AD-A247 182

Report No. CG-D-03-92

EVALUATION OF NIGHT VISION GOGGLES (NVG) FOR MARITIME SEARCH AND RESCUE (THIRD NVG REPORT)

R. Q. ROBE
U.S. Coast Guard Research and Development Center
1082 Shennecossett Road,
Groton, Connecticut 06340-6096

AND

J. V. PLOURDE and G. L. HOVER
Analysis & Technology, Inc.
258 Bank Street, New London, Connecticut 06320

INTERIM REPORT

JUNE 1991

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

Prepared for :

U.S. Department of Transportation
United States Coast Guard
Office of Engineering, Logistics, and Development
Washington, DC 20593

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

The contents of this report reflect the views of the Coast Guard Research & Development Center, which is responsible for the facts and accuracy of data presented. This report does not constitute a standard, specification or regulation.

Samuel F. Powel, III
Technical Director
U.S. Coast Guard Research & Development Center
1082 Shennecossett Road
Groton, CT 06340-6096

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CG-D-03-92		

4. Title and Subtitle	5. Report Date
Evaluation of Night Vision Goggles (NVG) for Maritime Search and Rescue (Third NVG Report)	June 1991
	6. Performing Organization Code
7. Author(s) R.Q. Robe, J.V. Plourde, and G.L. Hover	8. Performing Organization Report No. CGR&DC 19/91
9. Performing Organization Name and Address U. S. C. G. R&D Center 1082 Shennecossett Road Groton, CT 06340-6096 Analysis & Technology, Inc. 190 Governor Winthrop Blvd. New London, CT 06320-6223	10. Work Unit No. (TRAIS) 11. Contract or Grant No. DTCG39-89-C-80671
12. Sponsoring Agency Name and Address Department of Transportation U.S. Coast Guard Office of Engineering and Development Washington, D. C. 20593	13. Type of Report and Period Covered Interim Report March 1989 - February 1991 14. Sponsoring Agency Code

15. Supplementary Notes

This report is the third in a series that will document the Improvement of Search and Rescue Capabilities (ISARC) Project at the U.S.C.G. R&D Center and twenty-ninth in a series of R&D Center reports dealing with Search and Rescue.

16. Abstract

Three experiments were conducted during 1989 and two more have been conducted during 1990 by the U.S. Coast Guard Research and Development (R&D) Center to evaluate night vision goggles (NVGs) for their effectiveness in detecting small targets at night. Three types of NVGs were evaluated: the AN/AVS-6 Aviators Night Vision Imaging System (ANVIS) NVG was tested onboard Coast Guard HH-3 and CH-3 helicopters, and the AN/PVS-5C and AN/PVS-7A NVGs were tested onboard 41-foot Coast Guard utility boats (UTBs). During the Fall 1990 experiment, 4-and 6-person unlit life rafts, with and without retro-reflective tape and 18-and 21-foot white boats were employed as targets during realistically-simulated search missions and are discussed herein. A large quantity of well moonlit data were collected during the fall 1990 experiment and this third interim report discusses target types where new information was obtained.

A total of 1,612 target detection opportunities were generated for the above-mentioned target types during the five experiments. These data were analyzed to determine which of 25 search parameters of interest exerted a statistically-significant influence on target detection probability. Lateral range curves and sweep width estimates are developed for each search unit/target type combination. Human factors data are presented and discussed. Recommendations for conducting NVG searches for small targets and for additional data collection and analysis are provided.

17. Key Words	18. Distribution Statement
Search and Rescue, Night Vision, Night Vision Goggles, Sweep Width, Unlighted Targets	Document is available to the U.S. Public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED		

Form DOT F 1700.7 (8/72) Reproduction of form and completed page is authorized

METRIC CONVERSION FACTORS

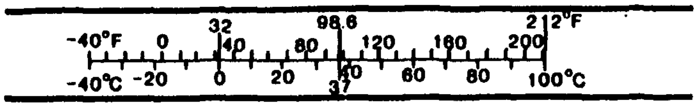
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10.286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



851.775

TABLE OF CONTENTS

TABLE OF CONTENTS (CONT'D)

LIST OF ILLUSTRATIONS

LIST OF TABLES

EXECUTIVE SUMMARY

INTRODUCTION

1. Background

This report provides a third interim evaluation of three types of night vision goggles (NVGs) for their effectiveness in the Coast Guard's maritime search and rescue (SAR) mission. The NVGs were evaluated onboard HH-3 and CH-3 helicopters from Coast Guard Air Stations Traverse City, MI, and Cape Cod, MA; on 41-foot utility boats (UTBs) from Coast Guard Stations Fort Pierce, FL, New London, CT, Point Judith, RI, and Montauk, NY. Data were collected during five 3-week experiments conducted in Fort Pierce, FL and Block Island Sound (off the CT/RI/NY coasts). This report will update analyses of NVG detection performance based on data that were obtained during the fall 1990 experiment which took place in Block Island Sound. Target types evaluated in this report include 4-and 6-person unlit orange canopied life rafts with or without retroreflective tape; white, 18-foot open boats; and white, 21-foot boats with blue canvas bow shelters and bimini tops.

These evaluations were conducted by the U.S. Coast Guard Research and Development (R&D) Center as part of the Improvement of Search and Rescue Capabilities (ISARC) Project. This research is ongoing, with an additional experiment and further data analyses planned for calender year 1991.

2. NVG Descriptions

Three NVG models were evaluated during the experiments onboard two types of search and rescue units (SRUs). The AN/AVS-6 Aviators Night Vision Imaging System (ANVIS) NVGs, equipped with Generation III photodetectors, were evaluated onboard the helicopters. All five helicopter crew positions were provided with ANVIS NVGs on hinged helmet mounts. UTB crews were provided with either AN/PVS-5C or AN/PVS-7A NVGs for use by lookouts only. The AN/PVS-5C and AN/PVS-7A are both equipped with Generation II-plus photodetectors and

fixed headstrap mounts. Helmsmen and coxswains positioned inside the UTB wheelhouse were unable to operate with these NVGs due to the lack of NVG-compatible instruments and radar displays.

All three NVG models restrict visual perception in several ways. All models restrict the users to a 40-degree field of view, severely inhibit depth perception, reduce visual acuity to 20/40 at best, and provide a monochromatic (green) display. The ANVIS and the AN/PVS-7A designs allow limited, non-NVG peripheral vision. The AN/PVS-5C design does not permit any peripheral vision.

3. Approach

Data were collected using operational Coast Guard search craft and crews that had received basic instruction in NVG use. Standard search patterns were used to search for randomly-placed targets within assigned search areas. Search crews were not alerted to target locations in advance.

A precision microwave tracking system was used to monitor and record target and search craft positions. Target detections and human-factors data were logged by data recorders onboard each search unit. Environmental data were logged onboard a chartered work boat. An environmental data buoy was deployed within each exercise area to record winds, sea conditions, and air/water temperatures.

Data reconstruction was performed to determine which target opportunities resulted in detection and at what lateral range each opportunity occurred. Raw data files were developed that included each target detection or miss along with the values of 25 search parameters of interest for each target opportunity. These data were analyzed on a desktop computer using a variety of statistical techniques including binary, multivariate regression analysis. Lateral range versus target detection probability plots and sweep width estimates were developed for search conditions that were well-represented in the data.

Human factors data were compiled and analyzed quantitatively where possible. Subjective comments by search unit crews and data recorders were summarized and incorporated into the conclusions and recommendations provided in this report.

RESULTS AND CONCLUSIONS

1. Results

A total of 1,612 detection opportunities were reconstructed from the six experiments for the target types discussed in this report. Table 1 provides a breakdown of data quantities categorized by search unit and target type. Six search unit/target type combinations were evaluated during the fall 1990 experiment. Table 2 summarizes the range of search conditions represented in the data set. Significant well moonlit data were obtained from the helicopter while searching for boat and raft without retroreflective tape targets and environmental conditions are now sufficiently represented in these data subsets to evaluate their effects on detection performance.

Table 1. Numbers of Target Detection Opportunities by SRU and Target Type

TARGET TYPE	SRU TYPE	
	Helicopter	UTB
18- and 21-foot Boats	570	194
4- and 6-person Life Rafts without Retroreflective Tape	395	218
4- and 6-person Life Rafts with Retroreflective Tape	100	135

Table 2. Range of Environmental and Moon Parameters Encountered

SRU/ TARGET	ENVIRONMENTAL PARAMETERS									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover (tenths)	Significant Wave Height (ft)	Whitecap Coverage	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
Helo/Boats	0 to 1	1.5 to 15	1.6 to 20	0 to 1.0	1.3 to 4.3	0 to 2	51 to 96	10.4 to 24.3	13.4 to 24.2	-68 to 65	none to full
Helo/Rafts w/retro-tape	0 to 0	15 to 15	8 to 16	0 to .4	1.6 to 4.3	0 to 1	50 to 71	15.7 to 23.0	18.4 to 22.5	-66 to 22	quarter to full
Helo/Rafts w/out retro-tape	0 to 3	1.5 to 15	3 to 16	0 to .1	1.6 to 5.2	0 to 2	51 to 100	10.4 to 24.3	13.4 to 23.0	-69 to 69	none to full
UTB/ Boats	0 to 1	1.5 to 15	1.6 to 20	0 to 1.0	1.3 to 4.3	0 to 2	51 to 96	5.5 to 24.3	13.4 to 24.2	-60 to 51	none to full
UTB/Rafts w/retro-tape	0 to 0	.5 to 15	5 to 17	0 to .4	1.6 to 4.3	0 to 2	50 to 95	15.2 to 23.9	17.5 to 22.1	-63 to 38	quarter to full
UTB/Rafts w/out retro-tape	0 to 2	1.5 to 15	2 to 24	0 to 1.0	1.3 to 4.6	0 to 2	51 to 100	6.1 to 24	13.5 to 23.6	-62 to 52	none to full

New or updated lateral range curve plots and sweep width (W) estimates were developed for the following SRU/target pairs and environmental conditions.

a. Helicopter/Life Raft Targets without Retroreflective Tape. Three sets of search conditions described below.

(1) Moon visible and

(i) Significant wave height (H_S) 1.6 to 2.3 feet, or

(ii) H_S 2.6 to 5.2 feet.

(2) Moon not visible.

b. Helicopter/Life Raft Targets with Retroreflective Tape. Two sets of search conditions described below.

(1) No whitecaps present.

(2) Whitecaps present.

c. Helicopter/Small Boat Targets. Three sets of search conditions described below.

(1) Moon visible and

(i) H_S 1.6 to 2.3 feet, and visibility 7 to 15 nmi, or

(ii) H_S 2.6 to 4.3 feet, and visibility 6 to 15 nmi.

(2) Moon not visible.

d. UTB/Life Raft Targets without Retroreflective Tape. Two sets of search conditions described below.

(1) Moon visible.

(2) Moon not visible.

e. UTB/Life Raft Targets with Retroreflective Tape.

f. UTB/Small Boat Targets. Four sets of search conditions described below.

(1) 18-foot boat target and H_S 1.3 to 2.0 feet.

(2) 21-foot boat target and H_S 1.3 to 2.0 feet.

(3) 18-foot boat target and H_S 2.3 to 4.3 feet.

(4) 21-foot boat target and H_S 2.3 to 3.9 feet.

An updated analysis of detections by crew position confirmed the following trends, which were reported earlier.

a. The copilot position (left seat) made more detections than the pilot position (right seat) for all data sets. This difference is consistent across all target types, and suggests a degradation in search capability that results from constant scan-shifting by the pilot between NVGs outside the cockpit and unaided vision inside the cockpit even while not actually flying the aircraft. This difference now appears to be less significant than previous reports suggested.

b. In the aft section of the helicopter, the flight engineer, who usually searches through an open door with a wide field of view and no glass to reflect light, made more detections overall than either the rescue swimmer position or the avionics position.

c. Evaluation of the composite UTB data indicates that the starboard aft lookouts made more detections than the port aft lookouts. This may be because the cabin door is directly adjacent to the port aft lookout position. The open door may have allowed more light to interfere with NVG operation and more distraction of the port aft lookout due to conversations with personnel inside the wheelhouse.

2. Conclusions

a. The presence of a visible moon significantly improves ANVIS detection performance against life raft targets without retroreflective tape and small boat targets.

b. Analysis of limited data indicates that the addition of retroreflective tape to life rafts in accordance with Safety of Life At Sea specifications may improve their detectability by the ANVIS goggles.

c. The presence of a visible moon appears to significantly enhance UTB detection performance against life rafts without retroreflective tape.

d. The addition of retroreflective tape to 4-and 6-person life rafts does not appear to improve NVG detection performance on UTBs.

e. UTBs have a very low detection level for all target types when searching with NVGs.

RECOMMENDATIONS

The following interim recommendations are added to those reported previously. These recommendations are based on new information obtained during the spring 1990 NVG test.

Daylight visual sweep widths referenced below are tabulated in the National Search and Rescue Manual. Fatigue, weather, and speed corrections listed in the SAR Manual are not to be applied unless specified below.

1. NVG Searches With Helicopters

a. The following sweep width estimates should be used when the search object is a 4- or 6-person life raft without retroreflective tape.

moon visible in search area - multiply the daylight visual sweep width, corrected for weather only, by 0.5.

moon not visible in search area - multiply the daylight visual sweep width, corrected for weather only, by 0.3.

b. The following sweep width estimates should be used when the search object is a small (15-to 25-foot) boat target.

moon visible in search area and

H_S **less than or equal to 2.5 feet** - multiply the uncorrected daylight visual sweep width by 0.3.

H_S **from 2.5 to 4.3 feet** - multiply the uncorrected daylight visual sweep width by 0.25.

moon not visible in search area - multiply the uncorrected daylight visual sweep width by 0.15.

c. The following sweep width estimates should be used when the search object is a 4-or 6-person life raft with retroreflective tape.

no whitecaps visible in search area - multiply the uncorrected daylight visual sweep width by 0.4.

2. NVG Searches With UTBs

a. UTBs should not be outfitted with NVGs solely for the purpose of conducting nighttime search missions.

b. The following guidelines should be used when estimating sweep width for 4-to 6-person life raft targets without retroreflective tape.

moon visible in search area - multiply the uncorrected daylight visual sweep width by 0.16.

moon not visible in search area - multiply the uncorrected daylight visual sweep width by 0.05.

c. The following sweep width estimates should be used when the search object is a small boat target.

18-foot open boat target - multiply the daylight visual sweep width, corrected for weather only, by 0.07.

21-foot boat target with cabin or canvas shelter - multiply the daylight visual sweep width, corrected for weather only, by 0.17.

d. Sweep width for 4- or 6-person life rafts with retroreflective tape applied per SOLAS specifications should be estimated by multiplying the uncorrected daylight visual sweep width by 0.05.

3. Recommendations For Future Research

a. Data collection priorities for future NVG tests are listed below in descending order of preference.

- PIW targets without lights in moonlit conditions,
- raft targets with retroreflective tape in moonlit conditions,
- red safety lights in moonlit conditions (helicopter) or all conditions (UTB).

b. The HH-65A and HH-60J Coast Guard helicopters should be evaluated for their NVG search performance. Since the HH-65A and HH-60J carry smaller crews, it is possible that their NVG detection performance will not be as good as that reported here. Any performance differences should be identified and quantified to ensure that accurate sweep widths are available for these newer aircraft.

c. More NVG search performance data should be collected in moonlit conditions. Data for clear, calm moonlit conditions and helicopters searching for life rafts with retroreflective tape are especially lacking in the existing NVG data base.

d. Sources of NVG-compatible illumination should be evaluated on surface and air SRUs, particularly against targets that are not equipped with lights. These targets should include both retroreflective and non-retroreflective materials.

e. Larger surface SRUs (such as WPBs and WMECs) should be evaluated for their NVG search performance.

ACKNOWLEDGEMENTS

The authors would like to thank the many individuals from the numerous Coast Guard units that participated in the Fall 1990 research effort. In particular the personnel from the following units, without whom the operational field experiments would not have been possible; Air Station Cape Cod, Station Montauk, NY, Station New London, CT, and Station Point Judith, RI. The Coast Guard crews on the Search and Rescue Units from these stations devoted many exhausting night time hours to make the data collection effort a success. We extend our special thanks to the personnel from the Watch Hill Lighthouse Keepers Association and Aids to Navigation Team New Haven, CT, for providing logistical support during the field experiments. The crew of the R/V UConn deserve recognition for their assistance in target and environmental buoy deployments/recoveries during the experiment.

We also extend our appreciation for the services provided by Mr. A. Allen in preparation and deployment services for the environmental buoy and for his oversight of surface operations; Mr. M. Couturier and Mr. D. Brennen for Command and Control operations during the field tests; Mr. G. Reas for his expertise in servicing and maintaining the electical equipment and the night vision goggles; Mr. S. Ricard, Mr. R. Marsee, and Mr. C. Oates who provided field and target support and also for their assistance in data collection and analysis.

We would like to acknowledge the advice and critical review provided by Dr. David Paskausky during the planning and analysis phases of these experiments.

We would also like to thank the many other personnel from the Coast Guard R&D Center, and Analysis & Technology, Inc. who supported this research effort.

CHAPTER 1
INTRODUCTION

1.1 SCOPE AND OBJECTIVES

This report is the third of a series that will document the U.S. Coast Guard Research and Development (R&D) Center's evaluation of night vision goggles (NVGs) and other night vision devices for search and rescue (SAR) missions. To date, five experiments have been conducted in support of this evaluation. During 1989, one experiment was conducted in Fort Pierce, FL and two experiments were conducted in Block Island Sound off the CT/RI/NY coasts. Reference 1 presented an analysis of data collected during the first three experiments. During the spring of 1990 a second experiment was conducted in Fort Pierce, FL. Reference 2 presented an analysis of data gathered through the spring 1990 experiment. This report will present updated analyses of NVG detection performance using additional data from an experiment conducted in the fall of 1990. During this experiment, three types of NVGs were evaluated onboard HH-3 helicopters and 41-foot utility boats (UTBs) for their effectiveness in detecting small boat targets, 4- and 6-person life rafts without retro-reflective tape, and 4- and 6-person life rafts with retro-reflective tape. Data collected during the fall 1990 experiment have been combined with previous data where applicable. An additional experiment and data analysis is planned for the spring of 1991.

This evaluation of night vision devices is part of the R&D Center's Improvement of Search and Rescue Capabilities (ISARC) Project. Project objectives are to improve search planning and execution and to evaluate visual and electronic search methods, leeway drift, ocean current drift, and visual distress signals. Specific objectives of the night vision device evaluations are to:

1. Establish the night SAR capabilities of operational Coast Guard search and rescue units (SRUs) equipped with these devices, and

2. Develop operationally-realistic sweep widths that search planners can use to represent Coast Guard night search effectiveness under a variety of environmental and lighting conditions.

1.2 NIGHT VISION GOGGLE SYSTEM DESCRIPTIONS

The AN/AVS-6 Aviator's Night Vision Imaging System (ANVIS) has been evaluated onboard Coast Guard HH-3F and CH-3E helicopters. The AN/PVS-5C and AN/PVS-7A NVGs have been evaluated onboard Coast Guard 41-foot UTBs. All three NVG models amplify available light to produce a monochromatic (green) image of the nighttime scene. As ambient light level varies, NVG image quality varies: Too much or too little light can cause poor image quality. All of the NVG systems evaluated severely inhibit depth perception and reduce visual acuity to no better than 20/40. Sections 1.2.1 and 1.2.2 describe specific features of the three NVG systems.

1.2.1 AN/AVS-6 ANVIS

The ANVIS goggles shown in figure 1-1 are a helmet-mounted NVG system designed for use by helicopter crews operating in a broad range of night illumination conditions including starlight and overcast. Two Generation III image intensifier tubes are incorporated into a hinged, binocular assembly that can easily be flipped up or down by the aviator. Adjustments for diopter correction, range focus, interpupillary separation, vertical positioning, fore-aft positioning (eye relief), and tilt positioning are also incorporated into the ANVIS goggles.

When in use (down position), the binocular assembly is offset from the eyes so that limited non-NVG peripheral vision is available. The eyes may also be focused beneath the goggles to view instruments and controls. The ANVIS goggles provide a 40-degree field of view (FOV). Peak spectral response is achieved with the ANVIS between wavelengths of 0.65 and 0.90 microns, which includes visible light from green through red and a portion of the near-infrared spectrum. A "minus blue" instrument light filter that eliminates wavelengths smaller than 0.625 microns (yellow) is incorporated into the ANVIS. An automatic brightness control adjusts rapidly to changing illumination conditions.

The ANVIS goggles tested during the three R&D Center experiments were manufactured by ITT Electro-Optics Division, Litton Electron Devices, and Varian Corporation. Detailed ANVIS specifications and principals of operation can be found in references 3 and 4.

Figure 1-1. AN/AVS-6 ANVIS Night Vision Goggles

1.2.2 AN/PVS-5C and AN/PVS-7A NVGs

The AN/PVS-5C and AN/PVS-7A/NVGs shown in figures 1-2 and 1-3, respectively, are infantry-type NVGs designed to be worn with fixed headstrap mounts. The AN/PVS-5C goggles tested were Litton Model M-915A, incorporating 2 Generation II-plus image intensifier tubes and an available short-range infrared illuminator (not evaluated). The AN/PVS-7A goggles tested were Litton model M-972, incorporating a single Generation II-plus image intensifier, a short-range infrared illuminator (not evaluated), and a binocular lens assembly. Adjustments for diopter correction, range focus, interpupillary separation, tilt positioning and fore-aft (eye relief) positioning are incorporated into both of these NVG models. The headstrap assemblies for both models adjust to fit the individual wearer.

When used with the headstrap assemblies, peripheral vision is unavailable with the AN/PVS-5C and restricted with the AN/PVS-7A. Both NVG models provide a 40-degree FOV. Peak response is in the visible portion of the spectrum, with reduced amplification in the near-infrared to 0.86-micron wavelengths. Automatic brightness control is provided in both NVG models.

The AN/PVS-5C and AN/PVS-7A NVGs tested during the three R&D Center experiments were all manufactured by Litton Electron Devices. Detailed specifications can be found in references 5 and 6.

1.3 EXPERIMENT DESCRIPTIONS

A total of five experiments have been conducted to date in support of the NVG evaluation effort. From 17 April to 6 May 1989, a 3-week experiment was conducted off Fort Pierce, FL. Reference 7 documents the "quick-look" results summary from this test. From 18 September to 7 October and again from 23 October to 11 November 1989, two experiments were conducted in Block Island Sound off the CT/RI/NY coasts. Reference 8 documents the "quick look" results from the two Block Island Sound tests. From 5 March to 23 March 1990 a 3-week experiment was conducted off Fort Pierce, FL. Reference 9 documents the "quick-look" results summary from the March 1990 test. From 24 September to 12 October 1990 a 3-week experiment was conducted in Block Island Sound. Reference 10 documents the "quick-look" results summary from this test. Sections 1.3.1 through 1.3.6 provide detailed information concerning the five experiments.

Figure 1-2. AN/PVS-5C Night Vision Goggles

Figure 1-3. AN/PVS-7A Night Vision Goggles

1.3.1 Participants

The NVG experiments were controlled by the Surviellance Systems Branch of the Coast Guard R&D Center, 1082 Shennecossett Road, Groton, CT. R&D Center personnel assisted by contractor computer programmers and technicians erected, operated, and maintained a precision microwave tracking system (MTS) and a radio-equipped control center at each experiment site. The R&D Center Project and Test Managers arranged for primary logistics support to these facilities, handled liaison among all Coast Guard and contractor participants, and maintained top-level control of all experiment communications and data collection activities.

The prime contractor was Analysis & Technology, Inc. (A&T). A&T prepared test plans, installed MTS equipment and provided data recorders onboard participating SRUs, procured and maintained target craft, and provided a chartered workboat at each site to deploy and recover an environmental data buoy and target craft.

1.3.1.1 Florida Experiment, April 1989

During the first Florida experiment a Coast Guard HH-3F helicopter (CG 1469) from Air Station Traverse City, MI was provided on-site at St. Lucie County Airport with a seven-person crew. Pilots were rotated midway through the 3-week test period while the five-man aircrew remained for the entire period with three flying on any particular night. Coast Guard Air Station Clearwater, FL provided limited maintenance and logistics support to the Traverse City aircraft and crew during its deployment.

Coast Guard Station Fort Pierce, FL scheduled a 41-foot UTB (CG 41461) and crew for each night using its normal complement of personnel. Station Fort Pierce also provided dockage for the chartered workboat, provided staging area and dock space for target craft, and assisted A&T personnel with the handling of target craft. Experiment-related message traffic was passed to and from the R&D Center Test Manager via the Station Fort Pierce communications center.

A 95-foot workboat, the R/V OSPREY, was chartered by A&T from the Florida Institute of Technology (FIT) to provide on-scene support to the Florida experiment. The R/V OSPREY deployed and retrieved the instrumented environmental data buoy in the Fort Pierce exercise area. The R/V OSPREY also deployed and retrieved all target craft used during data collection and provided backup weather observations each night.

1.3.1.2 Block Island Sound Experiments, Fall 1989

During the fall 1989 Block Island Sound experiments Coast Guard Air Station Traverse City, MI provided a CH-3E helicopter on-site at Groton-New London Airport and a seven-person crew to support data collection. During the first experiment, aircraft number CG 9691 was provided with a complete aircrew change taking place midway through the 3-week period. During the second experiment, aircraft number CG 2793 was provided with a complete aircrew change taking place midway through the experiment. Coast Guard Air Station Cape Cod, MA provided limited logistics support to the Traverse City crews during these deployments.

Coast Guard Stations Montauk, NY, New London, CT, and Point Judith, RI were each scheduled to provide a 41-foot UTB nightly to support Block Island Sound data collection. Vessels that participated on one or more nights are listed below.

Unit	Vessel(s)
CG Station Montauk, NY	CG 41342
CG Station New London, CT	CG 41337, CG 41350
CG Station Point Judith, RI	CG 41385

Experiment-related message traffic was handled directly through the R&D Center in Groton, CT and a tenant command, the International Ice Patrol.

A 65-foot workboat, the R/V UCONN, was chartered by A&T from the University of Connecticut's Marine Sciences Institute to provide on-scene support to the two Block Island Sound experiments. The R/V UCONN deployed the environmental data buoy, handled all target deployments/retrievals and obtained backup weather observations. The environmental data buoy was recovered by the F/V QURANBAUG QUEEN under a direct charter from the R&D Center.

1.3.1.3 Florida Experiment, March 1990

During this Florida experiment a Coast Guard HH-3F helicopter (CG 1488) from Coast Guard Air Station Cape Cod, MA was provided on-site at St. Lucie County Airport with a seven-person crew. Aircrews were rotated midway through the 3-week test period. Coast Guard Air Station Clearwater, FL provided limited maintenance and logistics support to the Cape Cod aircraft and crew during its deployment.

Coast Guard Station Fort Pierce, FL scheduled a 41-foot UTB (CG 41341) and crew for each night using its normal complement of personnel. Station Fort Pierce also provided dockage for the chartered workboat, provided staging area and dock space for target craft, and assisted A&T personnel with the handling of target craft. Experiment-related message traffic was passed to and from the R&D Center Test Manager via the Station Fort Pierce communications center.

A 95-foot workboat, the R/V OSPREY, was chartered by A&T from FIT to provide c ;cene support to the Florida experiment. The R/V OSPREY deployed and retrieved the instrumented environmental data buoy in the Fort Pierce exercise area. The R/V OSPREY also deployed and retrieved target craft used during data collection and provided backup weather observations.

1.3.1.4 Block Island Sound Experiment, Fall 1990

During the fall 1990 Block Island Sound experiment Coast Guard Air Station Cape Cod, MA provided an HH-3F helicopter based at Air Station Cape Cod, Otis Air Force Base, MA. Two pilots, rotated weekly, and a three-person crew were assigned to support data collection. Aircraft number CG 1471 was provided for the whole 3-week experiment.

Coast Guard Stations Montauk, NY, New London, CT, and Point Judith, RI were each scheduled to provide a 41-foot UTB nightly to support Block Island Sound data collection. Vessels that participated on one or more nights are listed below.

Unit	Vessel(s)
CG Station Montauk, NY	CG 41342
CG Station New London, CT	CG 41337, CG 41350
CG Station Point Judith, RI	CG 41441

Experiment-related message traffic was handled directly through the R&D Center in Groton, CT and a tenant command, the International Ice Patrol.

A 65-foot workboat, the R/V UCONN, was chartered by A&T from the University of Connecticut's Marine Sciences Institute to provide on-scene support to the Block Island Sound experiment. The R/V UCONN deployed and retrieved the environmental data buoy, handled all target deployments/retrievals and obtained backup weather observations.

1.3.2 Exercise Areas

The exercise area for the Fort Pierce experiment was a 10- by 20- nmi area centered at 27°32.6'N, 80°09.0'W along a major axis of 160 degrees magnetic. Figure 1-4 depicts the Fort Pierce exercise area and indicates the locations of land-based MTS components. SRUs were assigned specific search patterns within this area, which varied in size from 4 by 8 nmi to 10 by 12 nmi, depending on target and SRU type.

The exercise area for the Block Island Sound experiment was an 8- by 12- nmi area centered at 41°12.5'N, 71°48.0'W along a major axis of 090 degrees magnetic. Search patterns ranging in size from 4 by 5 nmi to 8 by 12 nmi were assigned in various parts of the exercise area according to target type, SRU type and prevailing winds/seas. Figure 1-5 depicts the Block Island Sound exercise area and indicates the locations of land-based MTS components.

In both exercise areas, an operations center was established at the MTS master station location and equipped with all computer and communications equipment required to direct data collection activities and record target and SRU position information. This facility, known as R&D Control, was located at the Sea Palms Condominiums in Fort Pierce during the spring 1989 experiment; at Watch Hill Light on Block Island Sound during the fall 1989 and fall 1990 experiments; and at the Tiara North Condominiums in Fort Pierce during the spring 1990 experiment. These locations are depicted in figures 1-4 and 1-5.

1.3.3 Targets

Eight types of search targets have been used to date in the NVG evaluations. Targets deployed without lights have included simulated Persons In the Water (PIWs) with retroreflective tape-equipped personal floatation devices (PFDs), 4- to 6- person life rafts without retroreflective tape, 4- to 6-person life rafts with retroreflective tape applied in accordance with Safety of Life at Sea (SOLAS) specifications, and 18- and 21-foot boats. The PIW targets have also been tested with three types of lights attached to their PFDs. These light include a military-issue, 1-second "firefly" strobe light and both red and green chemical lights. No additional data were gathered for PIW targets during the fall 1990 experiment.

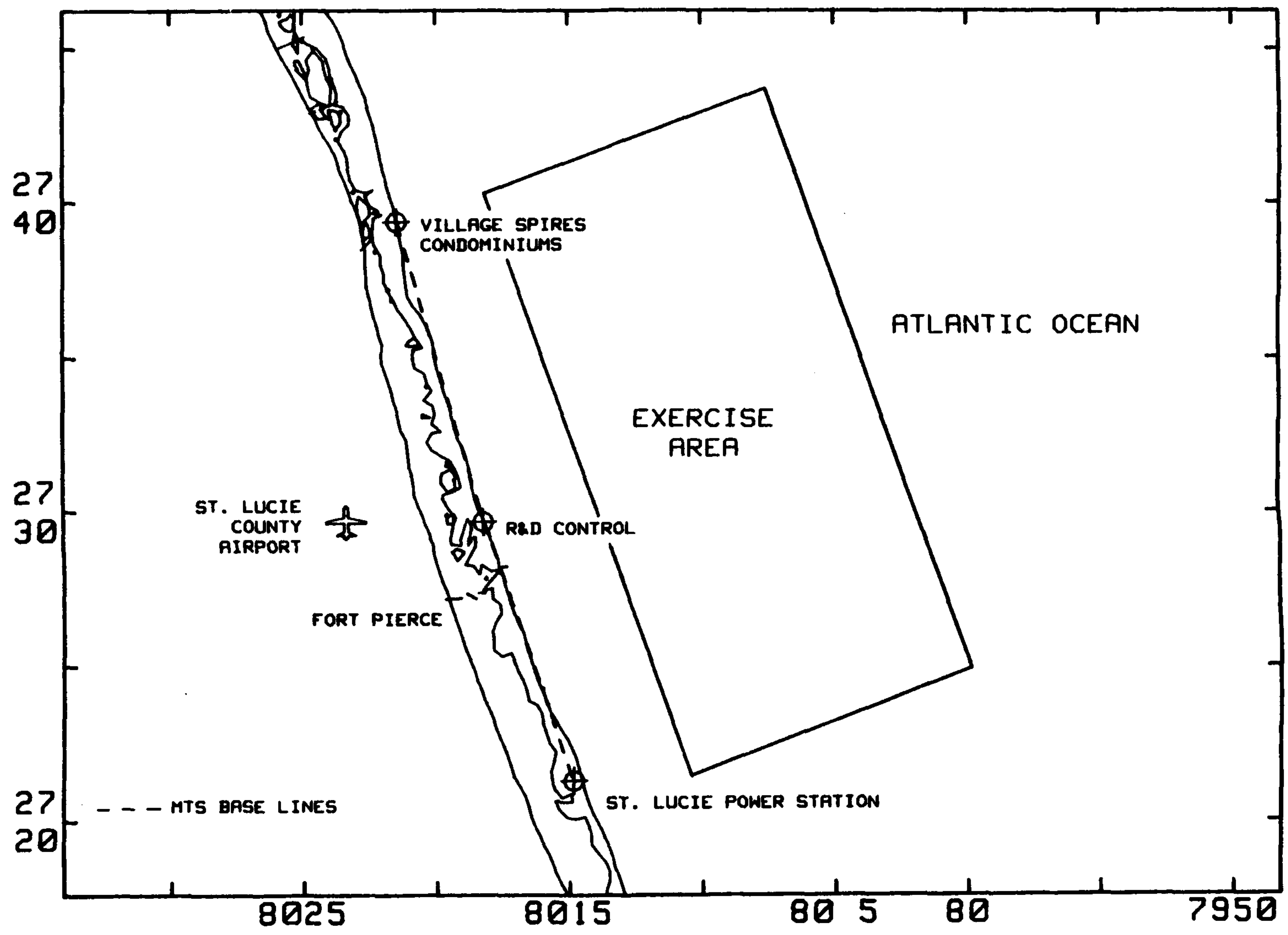


Figure 1-4. Fort Pierce Exercise Area

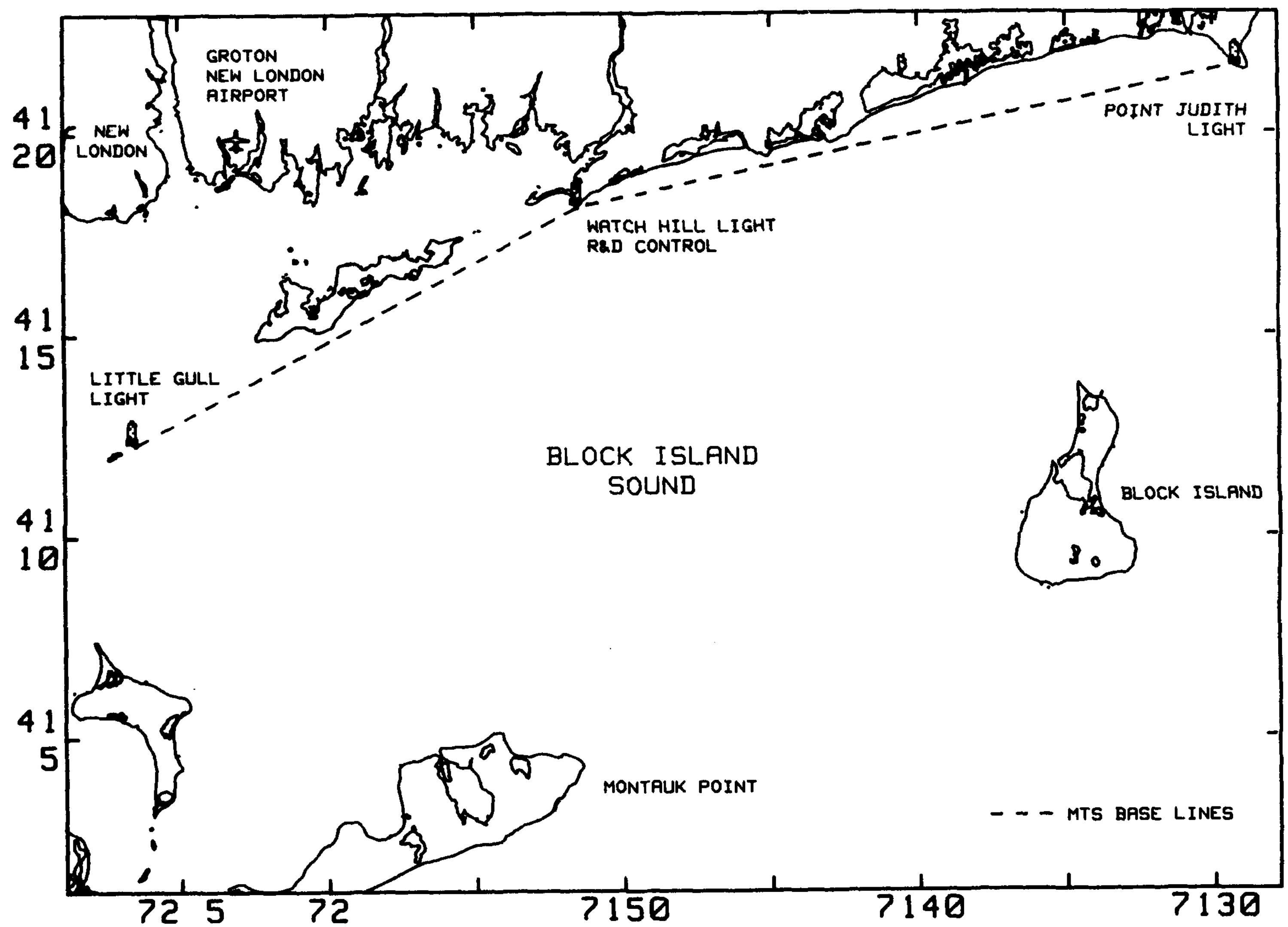


Figure 1-5. Block Island Sound Exercise Area

Table 1-1 provides the salient characteristics of each target type deployed during the fall 1990 experiment. Figures 1-6 through 1-9 provide representative photographs of these targets.

All targets were anchored at randomly-selected positions within the assigned search area each night before data collection started and recovered after all searching was completed. Target positions were selected by superimposing a 5 by 5 block grid (25 blocks total) on the assigned search area, generating a random grid number (1 to 25) for each target, and manually selecting a location for each target within its grid. Specific target positions within grids block were assigned with consideration given to bottom depth/type, currents, local shipping/fishing activity, and proximity of other targets.

Table 1-1. NVG Target Descriptions

TARGET (qty)	TARGET DESCRIPTION	DIMENSIONS length x beam x freeboard (feet)	PRINCIPAL MATERIAL
6-person raft (2)*	Avon or Beaufort w/orange canopy	7.2 dia. x 3.7 ht.	Rubber/ fabric
	Dunlop w/orange canopy	9.0 x 5.5 oval x 3.25 ht.	
4-person raft (2)*	Avon w/orange canopy	6.0 dia. x 3.5 ht.	Rubber/ fabric
	Viking w/orange canopy	5.5 square x 3.5 ht.	
Boat (3)	Rectangular white skiff w/console	18 x 7.5 x 1.6	Fiberglass
Boat (2)	Rectangular white skiff w/console, blue canvas bimini top, and blue bow shelter canvas	21 x 7.7 x 1.6	Fiberglass

* Rafts were deployed with or without the retroreflective tape exposed.

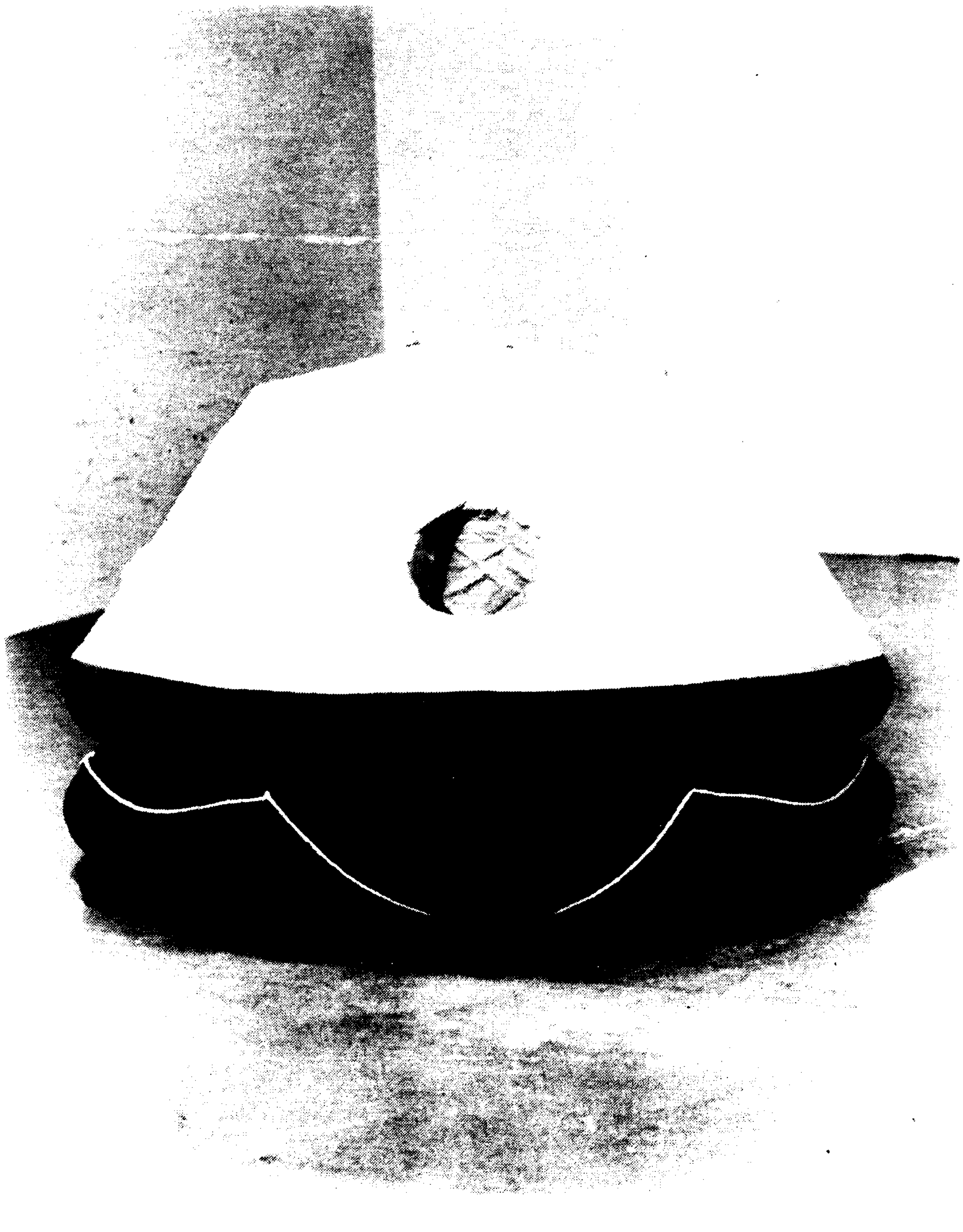


Figure 1-6. Six-Person Life Raft Target Without Retroreflective Tape

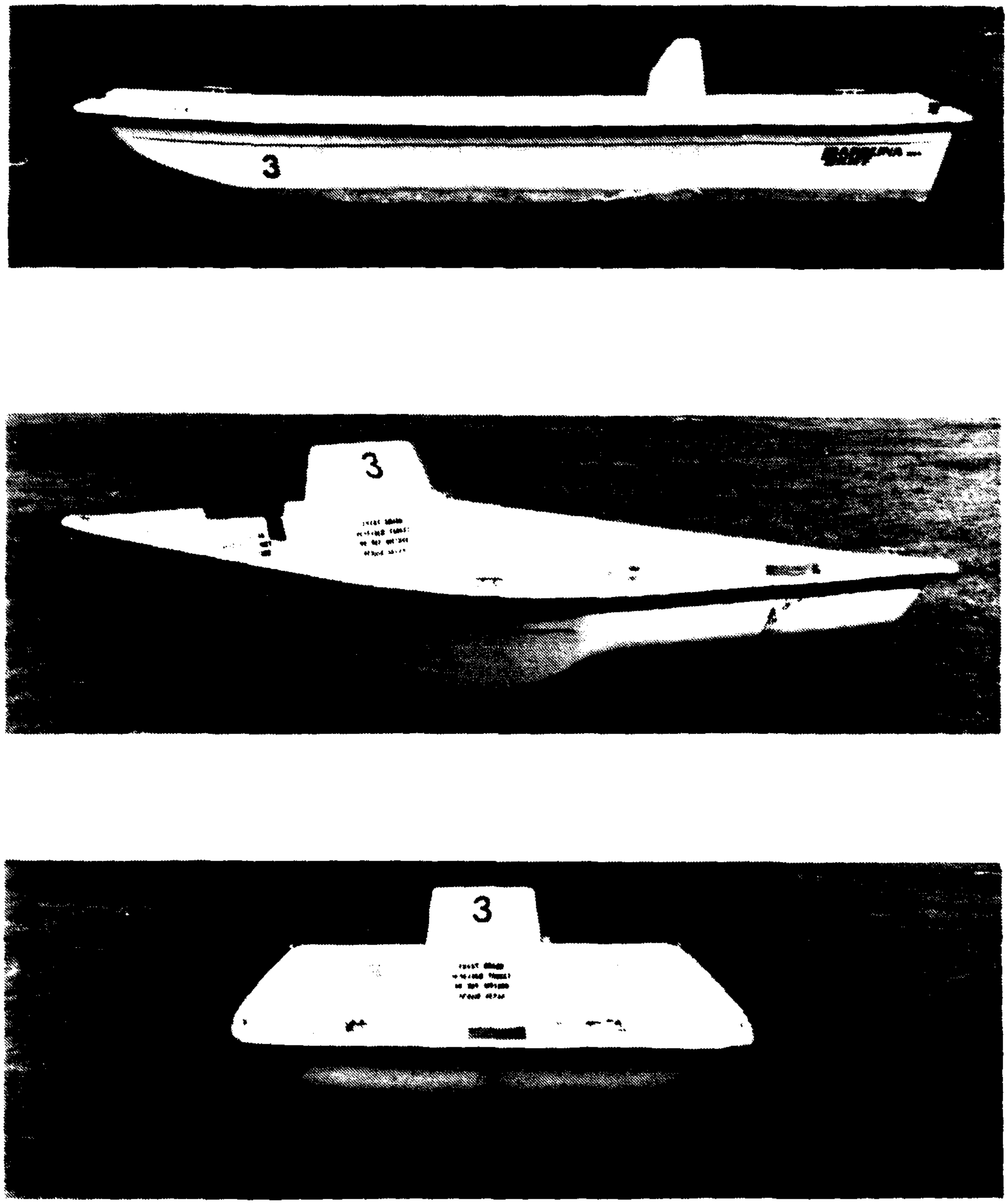


Figure 1-7. Eighteen-Foot Boat Target

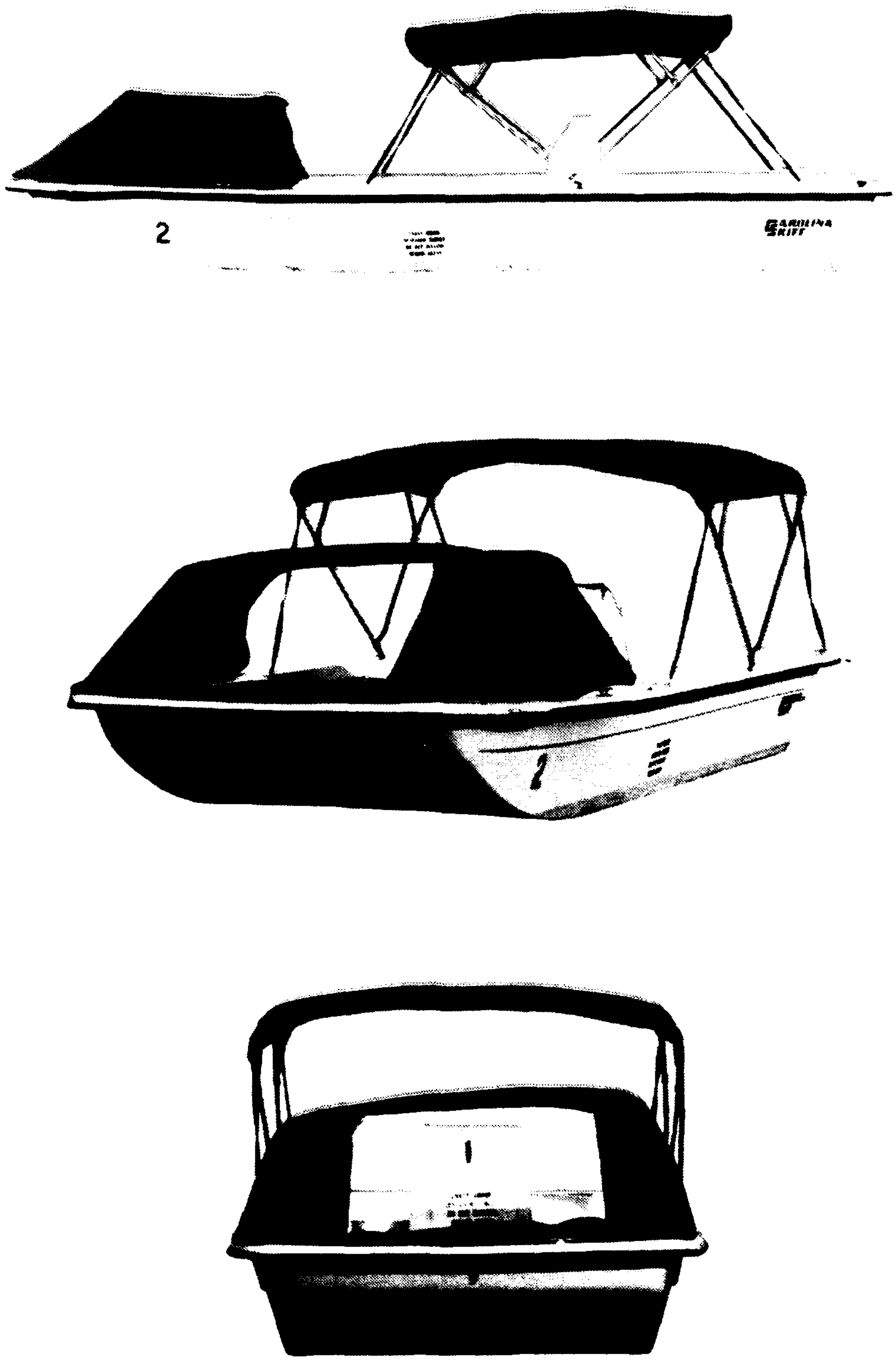


Figure 1-8. Twenty-One Foot Boat Target With Canvas

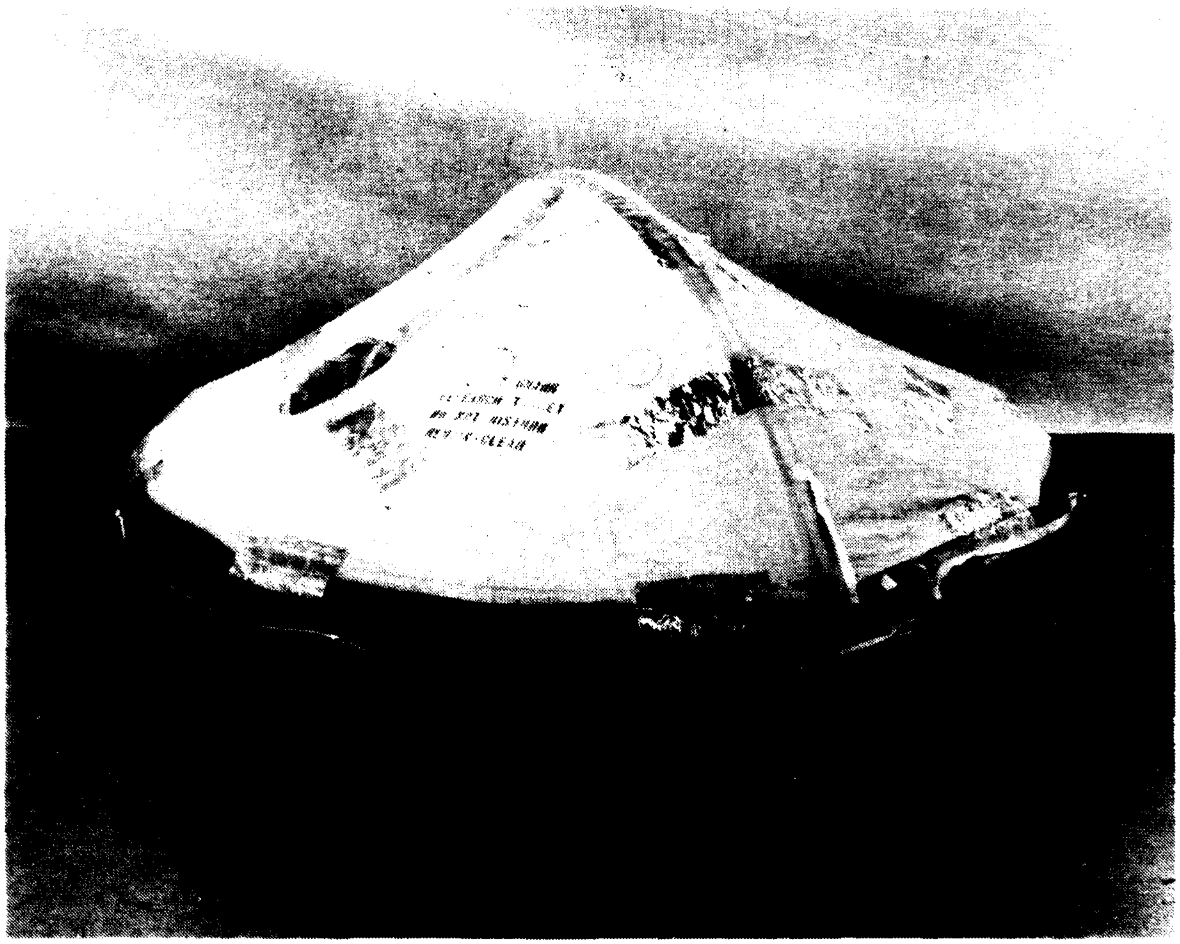


Figure 1-9. Four-Person Life Raft With Retroreflective Tape Applied in Accordance With SOLAS Specifications

1.3.4 Experiment Design and Conduct

Detection data were obtained by conducting operationally-realistic NVG searches using parallel single-unit (PS) and creeping line single-unit (CS) search patterns as defined in reference 11. Track spacing and search area dimensions were chosen to provide target detection opportunities at a variety of lateral ranges. All boat and raft searches were conducted using 1-nmi track spacing during the fall 1990 experiment Figures 1-10 and 1-11 illustrate the type of search instructions that were provided to participating SRUs during the experiments. Helicopters typically searched at a 300-foot altitude and used a 90-knot ground speed. UTBs used search speeds between 8 and 23 knots, depending on sea conditions. All search parameters were communicated to SRUs by means of a SAR Exercise (SAREX) message sent 12 to 24 hours before scheduled data collection.

In the interest of realism, SRU crews were composed of personnel from the normal complement at their respective air or boat stations. With the exception of the helicopter pilots, special training for the crews in the adjustment, care, and use of NVGs was usually limited to briefings and demonstrations by the R&D Center Test Manager or an A&T representative. Except for some of the helicopter pilots who had prior NVG flight experience in the Army, most SRU crewmembers had very little or no operational experience with NVGs. These experience and training levels are representative of what can currently be expected at many Coast Guard SAR facilities where NVGs are available. The SRU crews were instructed to treat the data collection sorties as they would an actual SAR case. The crews were encouraged to maintain motivational levels that would prevail during an actual SAR mission and to conduct operations as they normally would, with one key exception. In the interest of data collection efficiency, no diversions from the assigned search pattern were made by the SRUs for the purpose of confirming target sightings. Target confirmation was made through post-experiment data analysis.

Targets were anchored within the search area each night and were seldom moved until recovered. SRU crews knew which target type(s) were deployed each night but were never told where the targets were located and did not know the exact number of targets deployed each night. Crews were told to report to an onboard data recorder any sighting of an object that could conceivably be one of the search targets.

Geographic Analysis, Archiving & Display Station
Night Vision Goggles - Block Island Sound

Search Plan No. Creeping Line Search

Center: 41°12.5 N 71°48 W AXES: Major: 120/300°T Minor: 030/210°T
START: 41°11.22N 71°54.35W Right Length: 8.00 nm Track Spacing: 1.00 nm
Speed: 90 kts Time: 00:42 Width: 8.00 nm Track Miles: 63.00 nm
41°11.04 71°55.26 41°17.96 71°49.94 41°13.96 71°40.72 41°07.04 71°46.04

Waypoint	Latitude	Longitude	Course	Range	Cumulative Distance
1	41°11.22N	71°54.35W			
2	41°17.28N	71°49.7 W	030 °T	7 nm	7 nm
3	41°16.78N	71°48.55W	120 °T	1 nm	8 nm
4	41°10.72N	71°53.2 W	210 °T	7 nm	15 nm
5	41°10.22N	71°52.05W	120 °T	1 nm	16 nm
6	41°16.28N	71°47.4 W	030 °T	7 nm	23 nm
7	41°15.78N	71°46.24W	120 °T	1 nm	24 nm
8	41°09.72N	71°50.9 W	210 °T	7 nm	31 nm
9	41°09.22N	71°49.75W	120 °T	1 nm	32 nm
10	41°15.28N	71°45.09W	030 °T	7 nm	39 nm
11	41°14.78N	71°43.94W	120 °T	1 nm	40 nm
12	41°08.72N	71°48.59W	210 °T	7 nm	47 nm
13	41°08.22N	71°47.44W	120 °T	1 nm	48 nm
14	41°14.28N	71°42.79W	030 °T	7 nm	55 nm
15	41°13.78N	71°41.64W	120 °T	1 nm	56 nm
16	41°07.72N	71°46.29W	210 °T	7 nm	63 nm

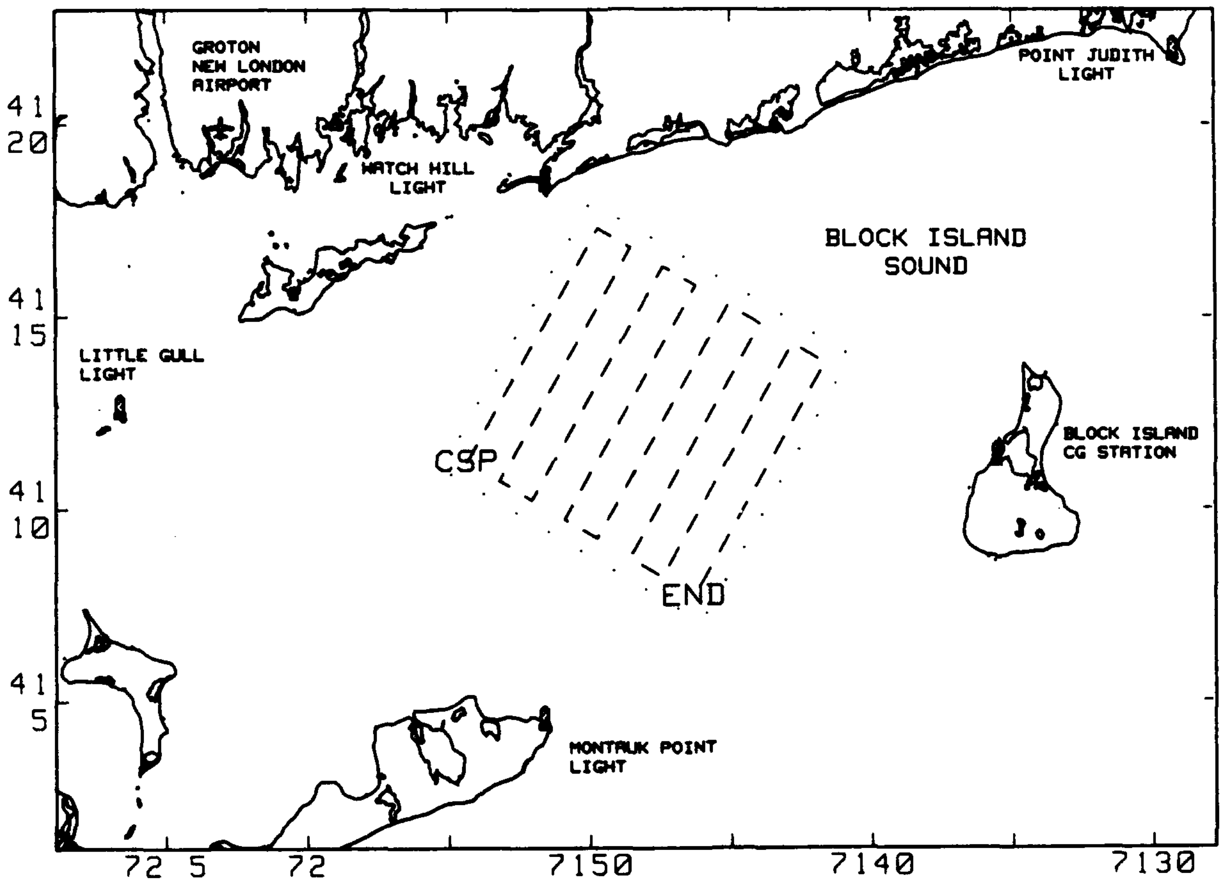


Figure 1-10. Example of Search Instructions Provided to Helicopter (Life Raft and Small Boat Targets)

Geographic Analysis, Archiving & Display Station
Night Vision Goggles - Block Island Sound

Search Plan No. Parallel Search

Center: 41°17.1 N 71°45.4 W AXES: Major: 075/255°T Minor: 165/345°T
START: 41°17.34N 71°50.65W Right Length: 8.00 nm Track Spacing: .50 nm
Speed: 15.0 kts Time: 03:10 Width: 3.00 nm Track Miles: 47.50 nm
Corners of search area: Area of this search: 24 sq nm
41°17.51 71°51.06 41°19.58 71°40.77 41°16.69 71°39.74 41°14.62 71°50.02

Waypoint	Latitude	Longitude	Course	Range	Cumulative Distance
1	41°17.34N	71°50.65W			
2	41°19.28N	71°41.01W	075 °T	7.5 nm	7.5 nm
3	41°18.8 N	71°40.84W	165 °T	.5 nm	8 nm
4	41°16.85N	71°50.48W	255 °T	7.5 nm	15.5 nm
5	41°16.37N	71°50.31W	165 °T	.5 nm	16 nm
6	41°18.31N	71°40.66W	075 °T	7.5 nm	23.5 nm
7	41°17.83N	71°40.49W	165 °T	.5 nm	24 nm
8	41°15.89N	71°50.13W	255 °T	7.5 nm	31.5 nm
9	41°15.4 N	71°49.96W	165 °T	.5 nm	32 nm
10	41°17.35N	71°40.32W	075 °T	7.5 nm	39.5 nm
11	41°16.86N	71°40.15W	165 °T	.5 nm	40 nm
12	41°14.92N	71°49.79W	255 °T	7.5 nm	47.5 nm

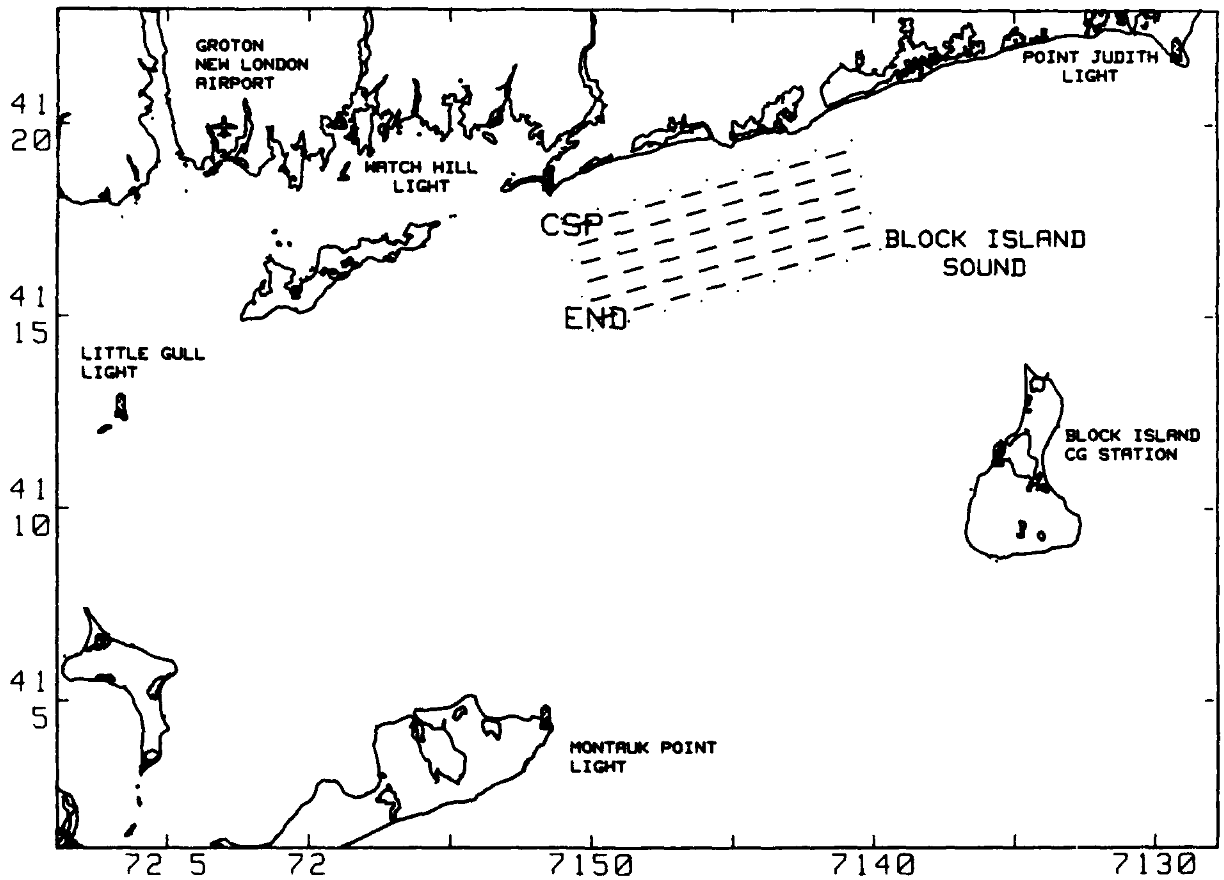


Figure 1-11. Example of Search Instructions Provided to UTBs (PIW Targets)

While NVGs were the primary sensor employed in these searches, a few incidental detections that were made by coxswains and helmsmen with the naked eye or with a radar assist are also included in the UTB data set. Helicopter crewmembers all wore the ANVIS goggles whenever searching and used radar only for avoiding severe weather.

Each night, a data recorder from A&T's field team accompanied each SRU to log human factors data, target detections, and crew comments. Crew information was recorded on the SRU Information Form (figure 1-12). Target detections, crew comments, and general observations were recorded on the NVG Detection Log (figure 1-13).

When a target was sighted, lookouts immediately relayed its relative bearing ("clock" method), its estimated range (expressed as a fraction of the distance to the horizon), and a brief description of its appearance to the data recorder. The data recorder then logged the detection time, relative bearing, range, visibility of the moon, SRU heading, lookout position, and remarks on the NVG Detection Log. Times were synchronized to the nearest second with the MTS clock so that detections could be validated during post-experiment analysis of the logs and SRU track histories. The data recorders were instructed not to assist with the search effort in any way and did not wear NVGs while recording data.

On-scene environmental conditions were recorded using two methods. An A&T technician onboard the chartered workboat recorded environmental data on the Environmental Conditions Summary (figure 1-14). The MiniMet environmental data buoy relayed information to the R&D Control facility over a UHF data link three times per hour. This information was also stored in an internal memory onboard the buoy as a backup.

Figure 1-15 depicts the data messages received from the buoy. Two of the three hourly messages relayed wind data, water temperature, and air temperature at 10 minutes and 40 minutes past the hour. At 30 minutes past the hour, wave spectrum data including significant wave height (H_S) were relayed. The buoy was the preferred environmental data source when both sets of information (work boat and buoy) were available.

SRU INFORMATION FORM

DATE ____________________ MTS TRANSPONDER CODE ____________________

SRU TYPE ________________ SERIAL NUMBER ____________________

COAST GUARD COMMAND ________________________________

NAVIGATION INPUTS USED
(check all that apply)

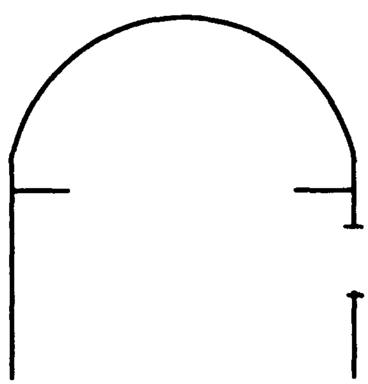
TACAN ___ VOR/DME ___ INS ___ LORAN-C ___ RDF ___ RADAR ___ DEAD REC. ___

CREW NAMES

POSITION	NAME	RANK	FUNCTION	EXPERIENCE W/NVG (hr)
A				
B				
C				
D				
E				
F				

SKETCH (show positions)

Aircraft



Vessel

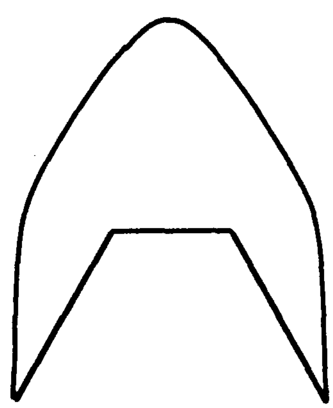


Figure 1-12. SRU Information Form

NVG DETECTION LOG

AIRCRAFT/BOAT NO. ______ SEARCH START TIME ______ DATE ______

TRANSPONDER CODE ______ SEARCH END TIME ______ SEARCH ______

NVG MODEL ______ SEARCH DURATION ______ SPEED ______

ALTITUDE ______

EVENT/ DETECTION NO.	TIME (HH:MM:SS)	SIGHTING RANGE (rel. to horiz.)	RELATIVE BEARING (deg/clock)	MOON VISIBLE? (Y/N)	SRU HEADING (deg T or M)	LOOKOUT/ POSITION	REMARKS (visibility, precip., fog, target appearance, etc.)

RECORDER: ______

Figure 1-13. NVG Detection Log

ENVIRONMENTAL CONDITIONS SUMMARY

REPORTING UNIT ___________ DATE ___________

TIME	SURFACE WIND		CLOUD COVER (tenths)	MOON VISIBLE (Y/N)	VISIBILITY (nmi)	WEATHER DESCRIPTION (clear, rain, fog, etc.)	SEA STATE			RELATIVE HUMIDITY (%)	AIR TEMP (°C)	WATER TEMP. (°C)
	TRUE SPEED (knots)	TRUE DIRECTION (deg M)					H_S^* (ft)	WHITE CAPS (N/S/M)	SWELL DIR (deg M)			
**METHOD OF MEASUREMENT												

*Significant wave height.
**Note: Method may be scientific (anemometer, radar, psychrometer, etc.) or an estimate. Indicate method used to measure each parameter.

OBSERVER: ___________________

Figure 1-14. Environmental Conditions Summary Form

Z901MET 890927 21 10 045 129 045 045 086 059 178 121 153 259800 439209 00
Buoy #901 - Met. Data - 27 Sep 1989 / 21:10:00
    Vector Wind Speed: 4.5 mps (8.75 knots)
    Vector Wind Direction: 129°M
    Average Wind Speed: 4.5 mps (8.75 knots)
    Average Azimuth Reading: 45°M
    Average Vane Reading: 86°M
    wind Gust: 5.9 mps (11.47 knots)
    Water Temperature: 17.8°C (64°F)
    Air Temperature: 12.1°C (53.8°F)
    Battery Voltage: 15.3 volts
    Loran Time Delays: 25980 / 43920.9 S/N: 0 C/S: 0
    Latitude/Longitude: 41°12.171'N / 71°47.905'W

1 Z901WAV 890927 21 087 110 104 095 112 113 126 175 174 206 204 239 246
2 Z901WAV 890927 21 239 223 204 206 198 189 193 196 168 189 171 187 205
3 Z901WAV 890927 21 224 241 255 251 245 250 001 004 009
Buoy #901 - Wave Data
    Record #1 - Wave Spectral Values 1 to 13 - 27 Sep 1989 / 21:30:00
        087 110 104 095 112 113 126 175 174 206 204 239 246
    Record #2 - Wave Spectral Values 14 to 26 - 27 Sep 1989 / 21:30:00
        239 223 204 206 198 189 193 196 168 189 171 187 205
    Record #3 - Wave Spectral Values 27 to 32 - 27 Sep 1989 / 21:30:00
        224 241 255 251 245 250
    Scaling Factor: 1
    Significant Wave Height: .4 m (1.3 ft)
    Maximum Wave Period: .9 sec

Z901MET 890927 21 40 051 115 051 045 072 062 178 118 158 259800 43209 00
Buoy #901 - Met. Data - 27 Sep 1989 / 21:40:00
    Vector Wind Speed: 5.1 mps (9.91 knots)
    Vector Wind Direction: 115°M
    Average Wind Speed: 5.1 mps (9.91 knots)
    Average Azimuth Reading: 45°M
    Average Vane Reading: 72°M
    wind Gust: 6.2 mps (12.05 knots)
    Water Temperature: 17.8°C (64°F)
    Air Temperature: 11.8°C (53.2°F)
    Battery Voltage: 15.8 volts
    Loran Time Delays: 25980 / 43920.9 S/N: 0 C/S: 0
    Latitude/Longitude: 41°12.171'N / 71°47.905'W

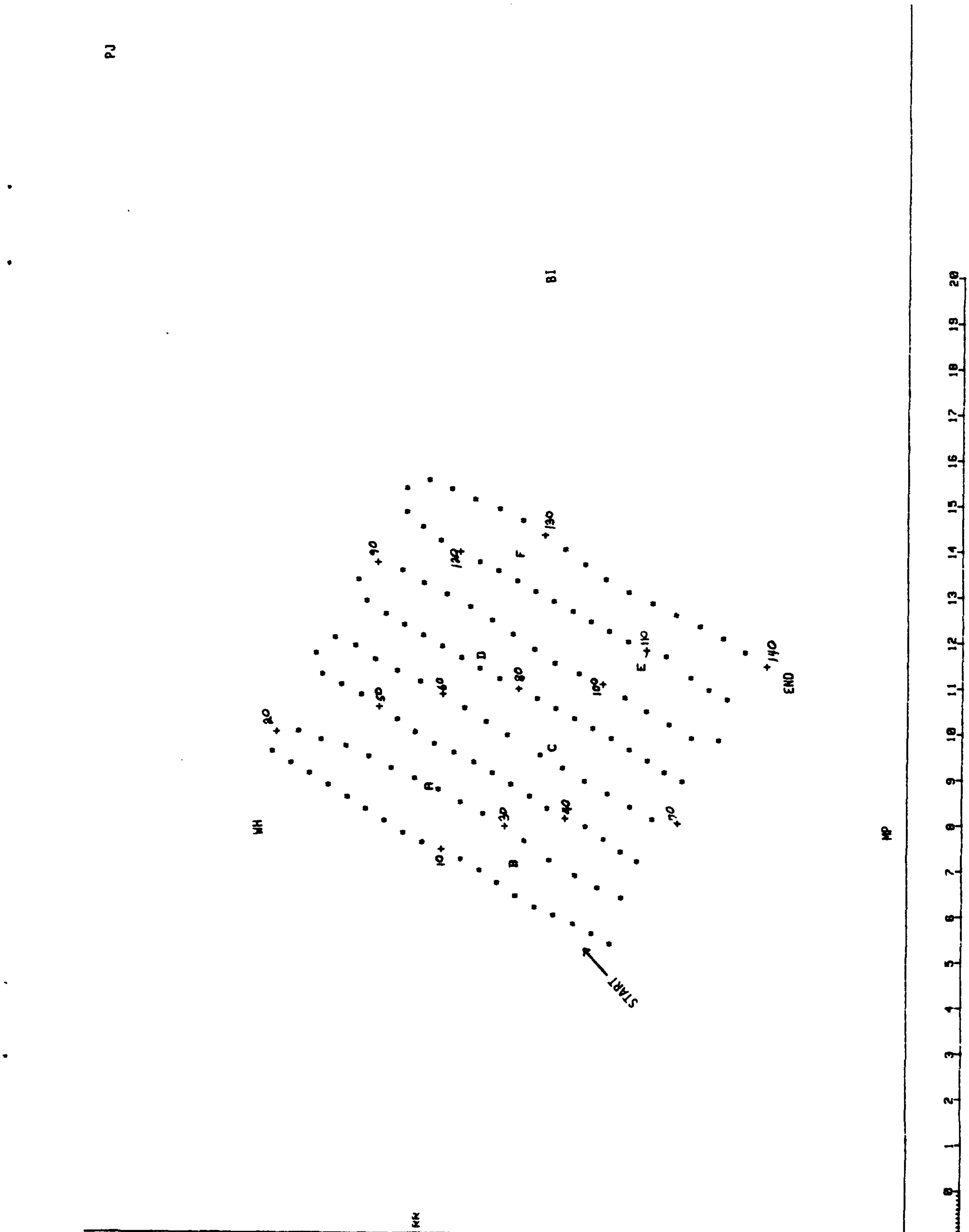
Figure 1-15. Environmental Data Buoy Message Formats

1.3.5 Tracking and Reconstruction

Target locations and SRU positions were monitored using the automated MTS consisting of a Motorola Falcon 492 system controlled by a Hewlett-Packard desktop computer. The controlling software system was developed by the R&D Center to provide real-time positioning and tracking with search reconstruction accurate to better than 0.1 nmi. A mobile MTS transponder was installed on the work boat for use in target positioning and on each SRU so that a track history of each search pattern could be generated. SRU positions were recorded continuously by the MTS, displayed in real time on a CRT at R&D Control, and recorded on a microcomputer hard disk every 10 to 30 seconds. Target positions were recorded by obtaining an MTS fix on the workboat when deploying and recovering each target, thus verifying that each position was unchanged while deployed. A more detailed description of this system can be found in reference 12.

In the Fort Pierce, FL exercise area the tracking system recorded the range from a transponder to the MTS Master Unit located on top of a high-rise condominium building in Fort Pierce and from a transponder to the two relay stations (located on a meteorological tower at the Florida Power and Light Company St. Lucie Plant and at the Village Spires condominiums in Riomar). These locations were depicted in figure 1-4. In the Block Island Sound exercise area, the tracking system recorded the range from a transponder to the Master Unit located at Watch Hill Light and from a transponder to the two primary relay stations (located at Little Gull Light and Point Judith Light). These locations were depicted in figure 1-5.

Search tracks and target locations were reconstructed by using the recorded target and SRU position data to generate an accurate geographic representation on hard copy plots. Figures 1-16 and 1-17 are MTS-generated reconstruction plots of actual searches that were conducted during the second Block Island Sound experiment. On each plot, target positions were plotted using identifying letters and the SRU track was identified by dots and plus signs. Plotting the SRU position marks created a trackline history for each search craft. Each position mark was associated with a known time on a hard copy printout that accompanied each plot. Figure 1-16 depicts the execution by a CH-3E helicopter of the search instructions which were shown in figure 1-10. Figure 1-17 depicts the execution by a 41-foot UTB of the search instructions which were shown in figure 1-11.



POD/SAR - NVG Test #3 - Fall 1989 - Block Island Sound
CG2793 (HH-3E) - Search #4 - 01 Nov 1989

Figure 1-16. MTS Plot of a Typical Helicopter Search

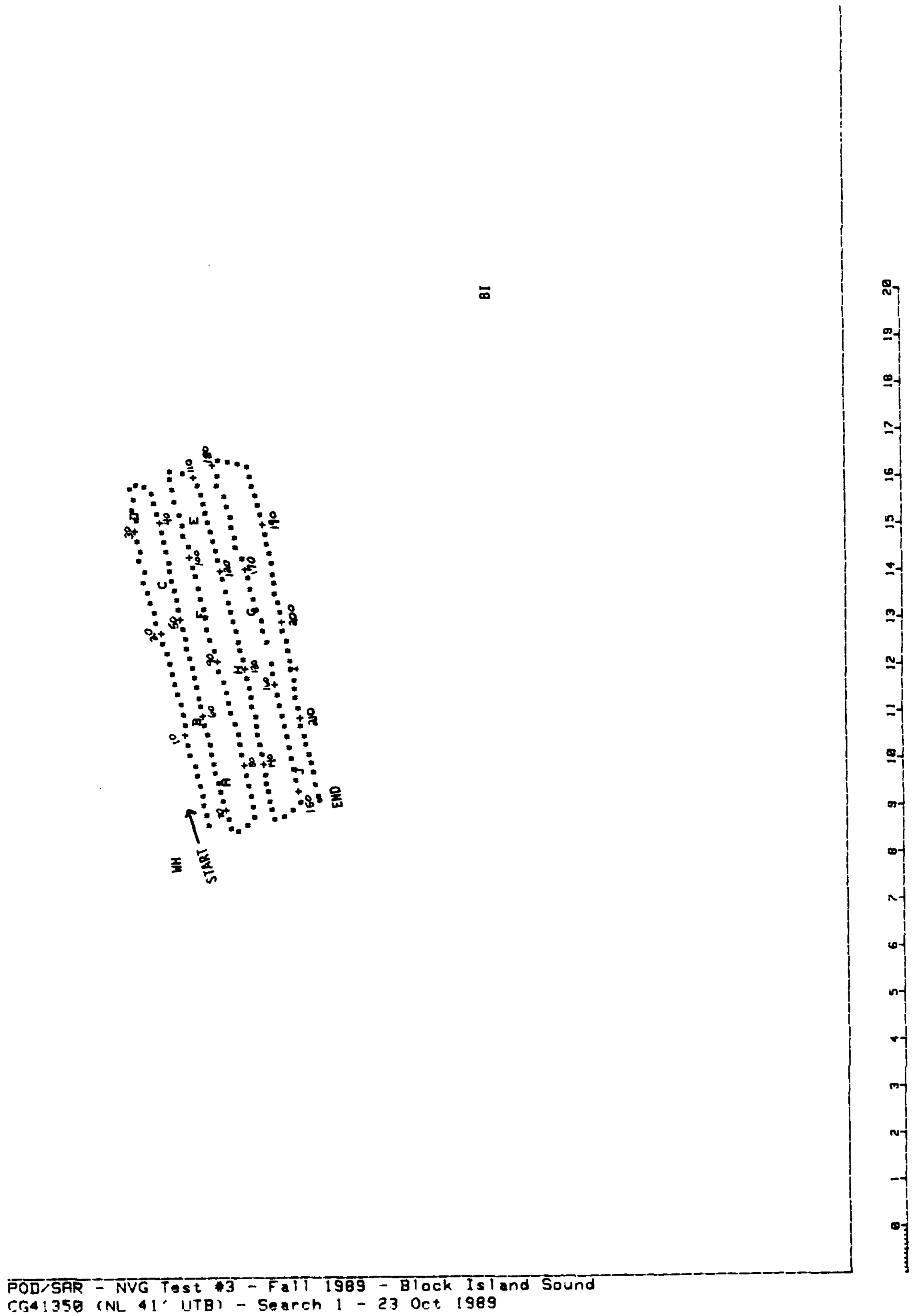


Figure 1-17. MTS Plot of a Typical UTB Search

Analysts used the MTS plots and NVG Detection Logs to determine which R&D Center targets were detected and which were missed on each leg of an SRU's search pattern. Normally, a target was considered an opportunity for detection on any given search leg if the SRU passed it within the assigned track spacing distance. Occasionally, analysts considered targets to be detection opportunities at distances greater than the track spacing. This was done when, on a given night, an SRU made one or more detections at lateral ranges that, when multiplied by 1.5, exceeded the assigned track spacing. In such instances, this computed distance (1.5 times maximum lateral range of detection) was used instead of the track spacing to determine which targets were considered valid detection opportunities. This rule, although somewhat arbitrary, provided sufficient data to identify an asymptotic limit to the NVG lateral range curve (to be discussed in section 1.4) without adding a large number of meaningless (very long-range) target misses to the data set.

If a logged target report could be correlated with the position of a given R&D Center target, it was considered a detection. Analysts performed this correlation by using the time of a given detection reported in the NVG Detection Log to locate the search craft on the hard copy MTS plot. The range and bearing information for that detection was then compared to target positions on the MTS plot, and a detection validity determination was made. A miss was recorded for any target detection opportunity that could not be correlated with a logged detection report on a particular search leg. An accurate lateral range measurement was then made on the MTS plot for each detection or miss. These detections and misses, along with associated search parameters and environmental conditions, were compiled into computer data files for analysis. Data files for the three 1989 experiments are listed in Vol. II of reference 1. Data files for the spring 1990 experiment were included in appendix A of reference 2. The appendix to this report contains the data files for the fall 1990 experiment in Block Island Sound.

1.3.6 Range of Parameters Tested

A total of 25 potentially-significant search parameters were recorded for each valid target detection opportunity. These parameters can be broadly classified as relating to the target, the SRU, the environment, ambient light, and human factors. These search parameters and their units of measure for the fall 1990 experiment are as follows:

PARAMETER		UNIT OF MEASURE
	Target-Related	
1.	Target Type	Rafts: with/without retroreflective tape Boats: 18-foot without canvas or 21-foot with canvas
2.	Lateral Range*	nautical miles
	SRU-Related	
3.	NVG Type	41-foot UTB: AN/PVS-5 or AN/PVS-7 Helicopters: AN/AVS-6 only
4.	Search Speed	knots
5.	Search Altitude	feet (helicopter only)
	Environment-Related	
6.	Precipitation Level	none/light/moderate/heavy
7.	Visibility	nautical miles
8.	Wind Speed	knots
9.	Cloud Cover	tenths of sky obscured
10.	Significant Wave Height	feet
11.	Whitecap Coverage	none/light/heavy
12.	Relative Wave Direction	wave fronts traveling into/away from/across line-of-sight to target at SRU's closest point of approach (if target missed) or at time of detection
13.	Relative Humidity	percent
14.	Air Temperature	degrees Celsius
15.	Water Temperature	degrees Celsius

*See section 1.4.1 for definition.

PARAMETER (Cont'd)	UNIT OF MEASURE (Cont'd)
Ambient Light-Related	
16. Relative Azimuth of Artificial Light	light source located along/away from/across line-of-sight to target at SRU's closest point of approach (if target missed) or at time of detection
17. Artificial Light Level	rural/suburban/urban
18. Moon Elevation	degrees above or below the horizon
19. Moon Visible (from SRU)	yes/no
20. Relative Azimuth of the Moon	moon (visible or not) located along/away from/across line-of-sight to target at SRU's closest point of approach (if target missed) or at time of detection
21. Moon Phase	none, 1/4, 1/2, 3/4, full
Human Factors-Related	
22. Lookout Position†	location onboard SRU
23. Lookout ID†	individual identifier
24. Lookout NVG Experience†	hours
25. Time on Task	hours (actually searching)

The range of target types evaluated was discussed in section 1.3.3. Lateral range for target opportunities varied from 0.0 to 4.0 nmi for boat targets and from 0.0 to 2.0 nmi for all life raft targets.

The types of NVGs used on each SRU were discussed in section 1.2. Helicopter search speed was approximately 90 knots for boat and liferaft targets. UTB search speeds varied between 8 and 23 knots depending on sea conditions. Search altitude for the helicopter was held constant at about 300 feet above the sea surface.

---

†Items 22 through 24 were recorded for detections only.

The range of environmental parameters encountered over the five experiments is summarized in table 1-2. Relative wave direction has been omitted from the table because all three possibilities are well-represented. Moon elevation and moon phase are also included in table 1-2. Artificial light levels were either rural or suburban in both locations.

A total of 55 individual helicopter lookouts and 132 UTB lookouts (not all of whom wore NVGs) are represented in the data set. NVG experience ranged from 0 to 140 hours for helicopter crewmembers and from 0 to 75 hours for UTB crewmembers. Time on task ranged from 0 to 3.7 hours for the helicopter crews and from 0 to 5.7 hours for UTB crews.

All remaining parameters were well-represented over their range of possible values.

1.4 ANALYSIS APPROACH

1.4.1 Measure of Search Performance

The primary performance measure used by SAR mission coordinators to plan searches is sweep width (W). Because this NVG evaluation is intended to support improved Coast Guard SAR mission planning, sweep width was chosen as the measure of search performance to be developed during data analysis. Sweep width is a single-number summation of a more complex range/detection probability relationship. Mathematically,

$$W = \int_{-\infty}^{+\infty} P(x)dx$$

where

x = Lateral range (i.e., closest point of approach) to targets of opportunity (see figure 1-18), and

$P(x)$ = Target detection probability at lateral range x.

Figure 1-19 shows a typical P(x) curve as a function of lateral range. In this figure, x is the lateral range of detection opportunities.

Table 1-2. Range of Environmental and Moon Parameters Encountered

SRU/ TARGET	ENVIRONMENTAL PARAMETERS									MOON	
	Precipitation Level	Visibility (nmi)	Wind Speed (knots)	Cloud Cover (tenths)	Significant Wave Height (ft)	Whitecap Coverage	Relative Humidity (percent)	Air Temperature (deg. C)	Water Temperature (deg. C)	Elevation (degrees)	Phase
Helo/Boats	0 to 1	1.5 to 15	1.6 to 20	0 to 1.0	1.3 to 4.3	0 to 2	51 to 96	10.4 to 24.3	13.4 to 24.2	-68 to 65	none to full
Helo/Rafts w/retro-tape	0 to 0	15 to 15	8 to 16	0 to .4	1.6 to 4.3	0 to 1	50 to 71	15.7 to 23.0	18.4 to 22.5	-66 to 22	quarter to full
Helo/Rafts w/out retro-tape	0 to 3	1.5 to 15	3 to 16	0 to .1	1.6 to 5.2	0 to 2	51 to 100	10.4 to 24.3	13.4 to 23.0	-69 to 69	none to full
UTB/ Boats	0 to 1	1.5 to 15	1.6 to 20	0 to 1.0	1.3 to 4.3	0 to 2	51 to 96	5.5 to 24.3	13.4 to 24.2	-60 to 51	none to full
UTB/Rafts w/retro-tape	0 to 0	.5 to 15	5 to 17	0 to .4	1.6 to 4.3	0 to 2	50 to 95	15.2 to 23.9	17.5 to 22.1	-63 to 38	quarter to full
UTB/Rafts w/out retro-tape	0 to 2	1.5 to 15	2 to 24	0 to 1.0	1.3 to 4.6	0 to 2	51 to 100	6.1 to 24	13.5 to 23.6	-62 to 52	none to full

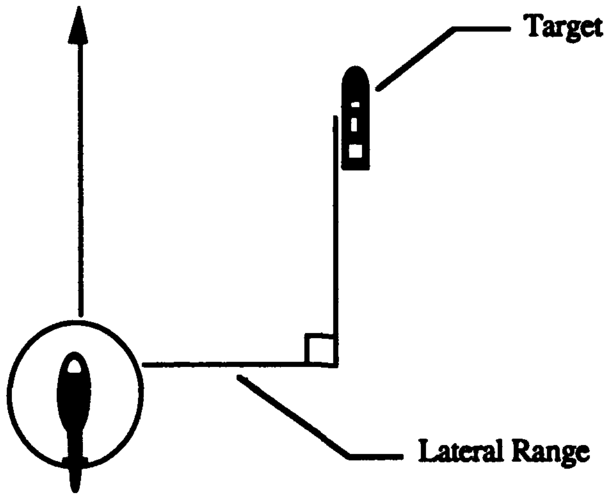


Figure 1-18. Definition of Lateral Range

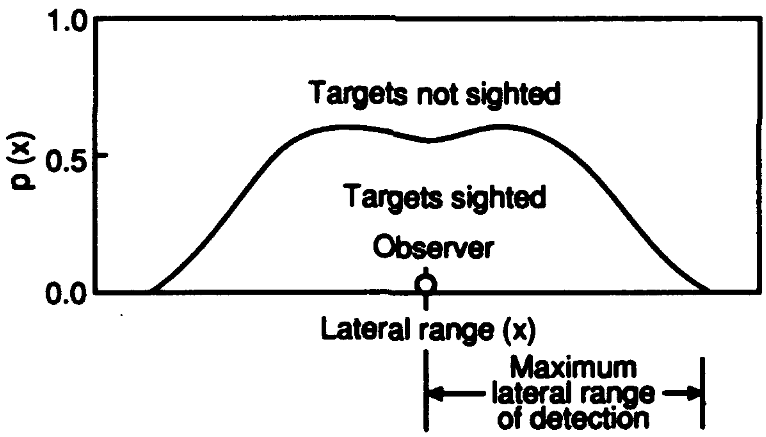


Figure 1-19. Relationship of Targets Detected to Targets Not Detected

Conceptually, sweep width is the numerical value obtained by choosing a value of lateral range less than the maximum detection distance for any given sweep so that scattered targets that may be detected beyond the limits of sweep width are equal in number to those that may be missed within those limits. Figure 1-20 (I and II) illustrates this concept of sweep width. The number of targets missed inside the distance W is indicated by the shaded portion near the top middle of the rectangle (area A); the number of targets sighted beyond the distance W out to maximum detection range (MAX R_D) is indicated by the shaded portion at each end of the rectangle (areas B).

Referring only to the shaded areas, when the number of targets missed equals the number of targets sighted (area A = sum of areas B), sweep width is defined. A detailed mathematical development and explanation of sweep width can be found in reference 13.

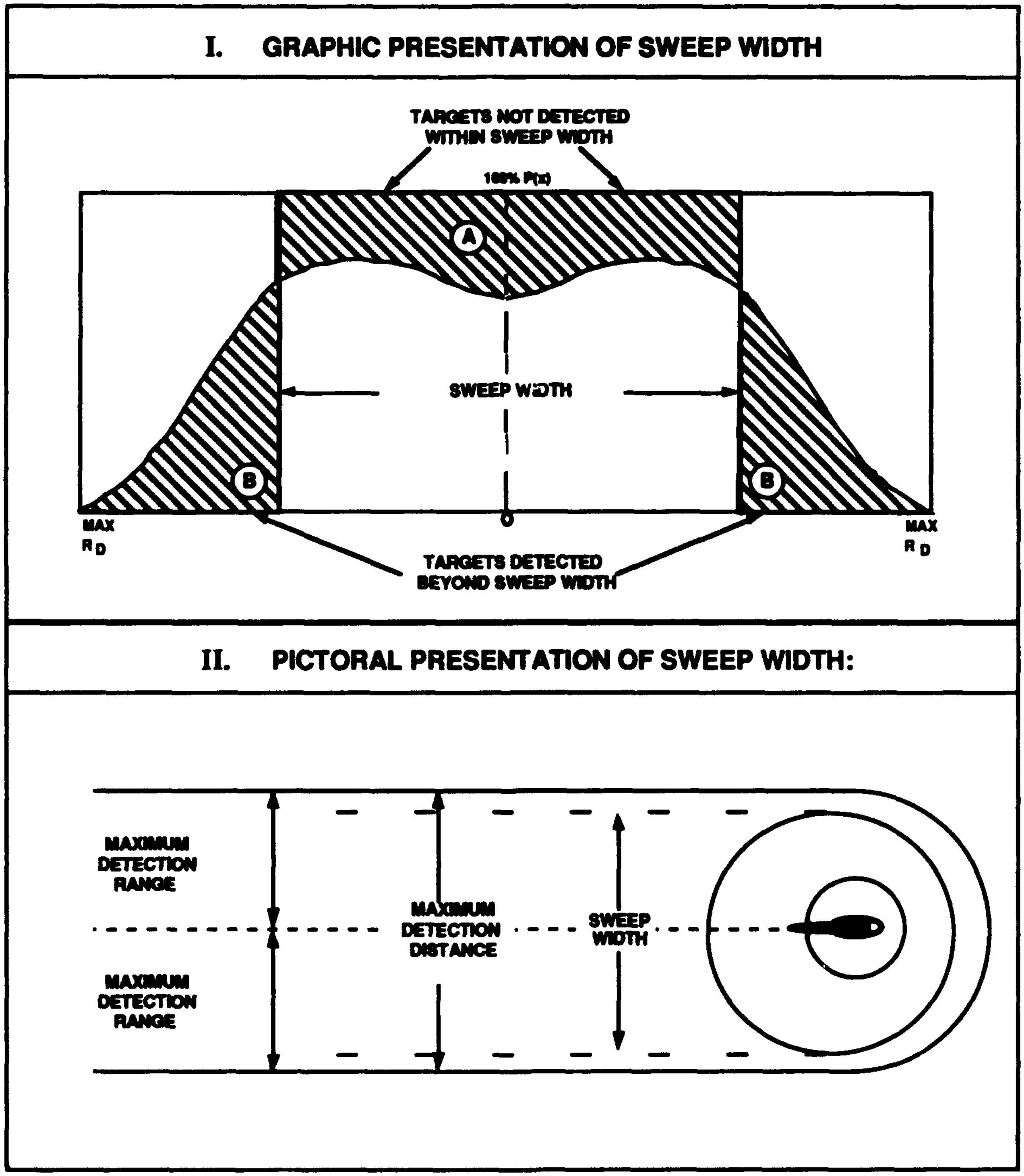


Figure 1-20. Graphic and Pictoral Presentation of Sweep Width

Three primary questions were addressed in this interim analysis of NVG detection data.

1. Which of the 25 search parameters identified in section 1.3.6 exerted significant influence on the detection performance of the SRUs against the 3 target types tested during the fall 1990 experiment?

2. What are the NVG sweep width estimates for various combinations of significant search parameters?

3. What guidance for NVG use onboard Coast Guard SRUs can be developed based on the quantitative analyses described above and the subjective comments and observations obtained from experiment participants?

1.4.2 Analysis of Search Data

1.4.2.1 Development of Raw Data

After each experiment, the MTS plots and NVG detection logs were used as described in section 1.3.5 to determine which SRU-target encounters were valid detection opportunities, and which of those opportunities resulted in successful target detections by the SRUs. The analyst listed each target detection opportunity on a raw data sheet along with a detection/miss indicator. Values for the 25 search parameters listed in section 1.3.6 were then obtained for each listed detection opportunity by consulting appropriate logs and environmental data buoy messages. A separate raw data sheet was completed for each search that was conducted by each SRU. The contents of these raw data sheets were entered into computer data files on an Apple Macintosh IIcx computer using spreadsheet software and stored on magnetic disk. A distinct data file was constructed for each SRU for each night it participated in data collection. Hard copies of the data files generated in the fall 1990 experiment are provided in appendix A of this report.

From these single-SRU data files, six aggregate raw data files were built; one file for each SRU/target type combination evaluated (two SRUs times three target types). These six raw data

files served as input to all subsequent data sorting and statistical analysis routines used for this evaluation.

1.4.2.2 Data Sorting and Statistics

Once the six files of raw data were entered and verified to be correct on the computer, basic statistics were obtained to characterize the data sets. A commercial statistics and graphics software package purchased from SYSTAT, Inc. was used to perform this phase of the data analysis.

Various SYSTAT routines were used to produce simple statistics, histograms, and scatter plots showing the range of search parameter values and their combinations present in each data set. The minimum, maximum, mean, and standard deviation values for each search parameter in the six data sets were obtained to determine the range of search conditions represented in each data set. Histograms showing the distribution of values for various parameters of interest were obtained to determine which search conditions were well-represented within each data set and which were not. Scatterplots depicting which combinations of search parameters were represented in each data set were also produced.

Once the data sets were characterized in this manner, logistic multivariate regression analysis was used to determine which search parameters exerted significant influence on NVG detection performance and to develop lateral range curves from which NVG sweep widths could be computed.

1.4.2.3 LOGIT Multivariate Regression Model

Multivariate logistic regression models have proven to be appropriate analysis tools for fitting Coast Guard visual search data where the dependent variable is a discrete response (i.e., detection/no detection). The detection data from this NVG evaluation have been analyzed using a commercially-available software package from SYSTAT, Inc. called LOGIT. LOGIT is an add-on module to SYSTAT's standard statistical analysis and graphics software package.

This type of regression model is useful in quantifying the relationship between independent variables (x_i) and a probability of interest, R (in this case the probability of detecting a target). The independent variables (x_i) can be continuous (e.g., lateral range, wave height, wind speed) or binary (e.g., high/low altitude, SRU type 0 or 1). For example, A&T's logistic regression model,

LOGODDS, has been used with great success during Improvement in Probability of Detection in Search and Rescue (POD/SAR) Project visual search performance analyses (reference 12). The LOGODDS model was shown to be an effective means of identifying statistically-significant search parameters and of quantifying their influence on the target detection probability versus lateral range relationship. This functional relationship, commonly referred to as the lateral range curve, provides a basis for computing sweep widths.

The equation for target detection probability that is used in the logistic regression model is

$$R = \frac{1}{1 + e^{-\lambda}}$$

where

R = target detection probability for a given searcher - target encounter,

λ = $a_0 + a_1x_1 + a_2x_2 + a_3x_3 + \ldots + a_nx_n$,

a_i = fitting coefficients (determined by computer program), and

x_i = independent variable values.

The method of maximum log-likelihood is employed in the model to optimize values of the coefficients a_i. A detailed theoretical development of the logistic regression analysis methodology is given in reference 14.

A logistic regression model has the following advantages over other regression models and statistical methods.

1. The model implicitly contains the assumption that $0 \leq R \leq 1.0$; a linear model does not contain this assumption unless it is added to the model (in which case computation can become very difficult).

2. The model is analogous to normal-theory linear models; therefore, analysis of variance and regression implications can be drawn from the model.

3. The model can be used to observe the effects of several independent or interactive parameters that are continuous or discrete.

4. A regression technique is better than nonparametric hypothesis testing, which does not yield quantitative relationships between the probability in question and the values of independent variables.

The primary disadvantages of a logistic regression model are:

1. For the basic models, the dependent variable (R) must be a monotonic function of the independent variables. This limitation can sometimes be overcome by employing appropriate variable transforms.

2. The computational effort is substantial, requiring use of relatively powerful computer resources. Until recently, a mini-mainframe computer (in the case of A&T's LOGODDS, a VAX 11/780) was required to perform the necessary calculations efficiently.

With the advent of more powerful desktop computers has come the capability to use them to perform multivariate logistic regression analyses on large data sets. The NVG detection data were analyzed on a Macintosh IIcx desktop computer using LOGIT. The LOGIT software (reference 15) uses the maximum log-likelihood method to fit a logistic curve to response data that can be broken down into discrete categories. As with LOGODDS, the influence of various independent explanatory variables on a discrete-choice response can be determined using the LOGIT module. The significance of these explanatory variables as predictors of the response can be evaluated using the output t-statistics. This process is equivalent to A&T's LOGODDS software, but allows for more than a binary (2-choice) response variable. When used to analyze a binary response data set, the LOGIT regression equation reduces to the same form as that given above for the LOGODDS model. Reference 16 documents a verification study performed by A&T that confirms the equivalence of the LOGODDS and LOGIT models for analysis of binary response data from Coast Guard detection performance evaluations.

The LOGIT regression model was used in an iterative fashion with each data set to arrive at a fitting function that contained only those search parameters found to exert statistically-significant influence on the target detection response. These fitting functions were then solved for representative sets of search conditions to generate lateral range curves. From these lateral range curves, NVG sweep widths were computed.

1.4.2.4 Sweep Width Calculations

Sweep width, the measure of search performance used by Coast Guard search planners, was defined conceptually in section 1.4.1. Mathematically, the value of W is determined by computing the area under the lateral range curve. Before NVG sweep widths were computed for this report, the analysis procedure described in section 1.4.2.3 was used with the data set for each SRU/target type combination. This procedure identified search parameters that exerted statistically-significant influence on target detection probability. Histograms and scatterplots depicting the distribution of the significant parameters identified within each data set were then prepared. These histograms and scatterplots helped determine how the raw experiment data could be sorted into subsets of substantial size. These subsets would reflect distinct sets of search conditions. Lateral range curves and sweep widths were then computed for each data subset.

The preceding analysis procedure and the subsequent process of generating lateral range curves and computing sweep widths is best illustrated by the following example. This example is based on data collected through the 5 experiments conducted to date.

STEP 1: Identification of Data Subsets. LOGIT analysis of the data set representing helicopters searching for small boat targets indicated that lateral range, visibility, significant wave height (H_S), and the presence or absence of a visible moon exerted statistically-significant influence on target detection probability. The distribution of the data relative to moon visibility was determined from a simple data sort, rather than a histogram, because this parameter could assume only two values. The distributions of visibility and significant wave height within the data set were then examined by generating histograms depicting values of these variables versus frequency of occurrence. Finally, the combinations of these variables within the data set were depicted by creating scatterplots of the distribution of each variable relative to the others. These scatterplots, combined with the histogram information, identified three combinations of visibility, significant wave height, and moon visibility that were well-represented in the data set. The first set of search conditions was represented by no visible moon. When there was no moon, lateral range was the only factor to significantly affect probability of detection. The second set of search conditions was represented by a visible moon, visibilities of 7 to 15 nmi, and significant wave heights of 1.6 to 2.3 feet. The third set of search conditions was represented by a visible moon, visibilities of 6 to 15 nmi, and significant wave heights of 2.6 to 4.3 feet.

STEP 2: Generation of Lateral Range Curves. Two lateral range curve equations were generated for the well moonlit data subset by inputting the mean values of visibility and H_S for each of the data subsets into the LOGIT-generated expression for target detection probability. An additional lateral range curve equation was generated for the non-moonlit data subset using the LOGIT-generated expression for target detection probability. The three distinct equations that resulted were then plotted for lateral range values between 0 and 4 nmi. This process yielded three distinct plots of lateral range versus target detection probability; one for each combination of search parameters identified in step 1 above.

STEP 3: Calculation of Sweep Widths. Sweep width values were calculated for each of the three sets of search conditions by integrating the applicable LOGIT expressions for target detection probability over the limits 0 to 4 nmi. The integral of the two-choice LOGIT function given in section 1.4.2.3 is:

$$A = \frac{1}{a_1} \ln\left(1 + e^{a_1 x_1 + c}\right) \Bigg|_{x_1 = 0 \text{ nmi}}^{x_1 = \text{ selected lateral range limit}}$$

where

A = area under the LOGIT-fitted curve,

a_1 = value of the lateral range coefficient determined by the LOGIT regression analysis,

x_1 = lateral range, and

c = $a_0 + a_2 x_2 + ... + a_n x_n$ for specified values of search parameters $x_2, x_3, ...x_n$. In this example n = 3 with x_2 and x_3 representing the specified values of visibility (in nautical miles) and H_S (in feet). The values of a_0, through a_4 would be determined by the LOGIT regression analysis.

Sweep width is defined as two times the value of the area A computed above because searching occurs to both sides of the SRU, thus:

$$W = 2A.$$

The methods illustrated in the example above were used with all the SRU/target type combinations for which values of W were computed in this report. Integration limits were selected to include a lateral range interval from 0 nmi to a value well beyond the limits at which any detections were made during the experiments. These limits varied with SRU/target type combination.

This page intentionally left blank

CHAPTER 2
TEST RESULTS

2.1 INTRODUCTION

This chapter summarizes the results of the NVG data analyses described in chapter 1. Two major discussions of results are presented in this chapter: Section 2.2 provides a quantitative analysis of SRU detection performance against each of the target types tested and section 2.3 provides an evaluation of human factors studied during the NVG experiments.

During the 5 NVG experiments conducted to date a total of 1,612 target detection opportunities have been generated for the 3 target types that will be discussed in this report. Table 2-1 summarizes the distribution of these detection opportunities by SRU type and target type. Sufficient data to support detailed analyses using the methods described in chapter 1 were collected in all six of the SRU/target type categories listed.

2.2 DETECTION PERFORMANCE

Sections 2.2.1 and 2.2.2 present discussions and detailed analyses of each data subset listed in table 2-1. Lateral range curve fits and sweep width estimates are provided for statistically-significant search parameter combinations that are well-represented in the raw data. Raw data plots only are presented for data subsets which do not have sufficient data to support meaningful sweep width analysis. Lateral range and the presence or absence of a visible moon were identified as significant search parameters for three of the six SRU/target type combinations. Insufficient moonlit data exists for the raft targets with retroreflective tape to evaluate the effect of moonlight on their detectability.

Table 2-1. Numbers of Target Detection Opportunities by SRU Type and Target Type

TARGET TYPE	SRU TYPE	
	Helicopter	UTB
18- and 21-foot Boats	570	194
4- and 6-person Life Rafts without Retroreflective Tape	395	218
4- and 6-person Life Rafts with Retroreflective Tape	100	135

The lateral range plots depicted in this chapter show lateral range from the SRU along the horizontal axis and target detection probability along the vertical axis. The figures expressed as ratios on the plots represent the number of detections divided by the total number of target detection opportunities occurring within a particular lateral range interval. These ratios correspond to the target detection probability achieved for each lateral range interval. Each plotted probability is denoted by a diamond that is located along the horizontal axis at the average lateral range for all detection opportunities occurring within the applicable lateral range interval. A vertical bar through each diamond denotes the 90-percent confidence limits on the plotted detection probability. Fitted lateral range curves, where included, were generated using the LOGIT regression equation discussed in chapter 1 with all statistically-significant search variables included. When a data set was found to contain statistically-significant search variables in addition to lateral range, the mean values of these variables within the data set were input into the LOGIT equation. Each data subset plotted represents a unique combination of significant search variable values.

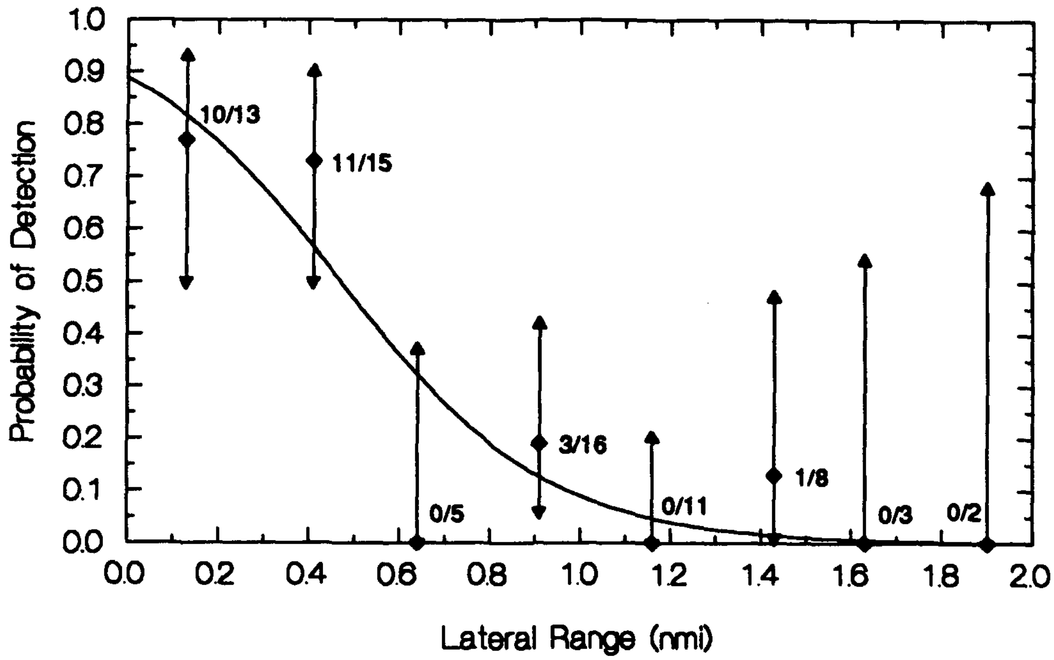
2.2.1 Helicopter Detection Performance

2.2.1.1 Life Raft Targets Without Retroreflective Tape

One hundred and thirteen new target detection opportunities were added by the fall 1990 experiment to the data set collected during four previous NVG experiments for this SRU/target combination. All of these new detection opportunities occurred in moonlit conditions. LOGIT regression analysis at the 90-percent confidence level indicated that variation in target detection probability within this data set could best be explained by a combination of the lateral range and moon visibility parameters. Within the moonlit data subset, a separate LOGIT regression analysis at the 90-percent confidence level indicated that significant wave height (H_S) was also a statistically significant predictor of target detection probability. The identification of moon visibility as a significant predictive parameter confirms the results reported in reference 2. The addition of H_S as a significant search parameter in moonlit conditions indicates that better lighting conditions cause parameters in addition to lateral range to become significant in explaining variability in target detection performance.

After LOGIT analysis, the 395 detection opportunities in this data set were first sorted into 2 levels of moon visibility (0 = not visible, 1 = visible). The initial data sort resulted in a group of 170 detection opportunities under moonlit conditions and 225 detection opportunities under moonless conditions. LOGIT regression was then performed separately on these two data sets. H_S was found to be a significant search parameter in moonlit conditions and this data subset was sorted into two levels of significant wave height ($H_S <= 2.5$ feet and $H_S > 2.5$ feet). Each of these three data subsets were then sorted into eight, 0.25-nmi lateral range bins from 0.0-nmi through 2.0-nmi to produce the raw data points plotted in figures 2-1, 2-2, and 2-3.

The LOGIT-fitted lateral range curves shown in figures 2-1, 2-2, and 2-3 were produced by solving the LOGIT regression model equation for the applicable moonlit condition (0 or 1) and, in the case of the moonlit data, for the mean value of H_S in the data subset. Each of the curves was generated for the 0 to 2-nmi lateral range interval. Sweep width estimates of 1.00, 0.63, and 0.36-nmi, respectively, were obtained by integrating the fitted LOGIT probability equations over the limits of 0 to 2 nmi.



* One non-detection at 2.2 nmi not shown here.

Figure 2-1. Helicopter Detection of Life Rafts Without Retroreflective Tape (moon visible, H_S <= 2.5 feet)

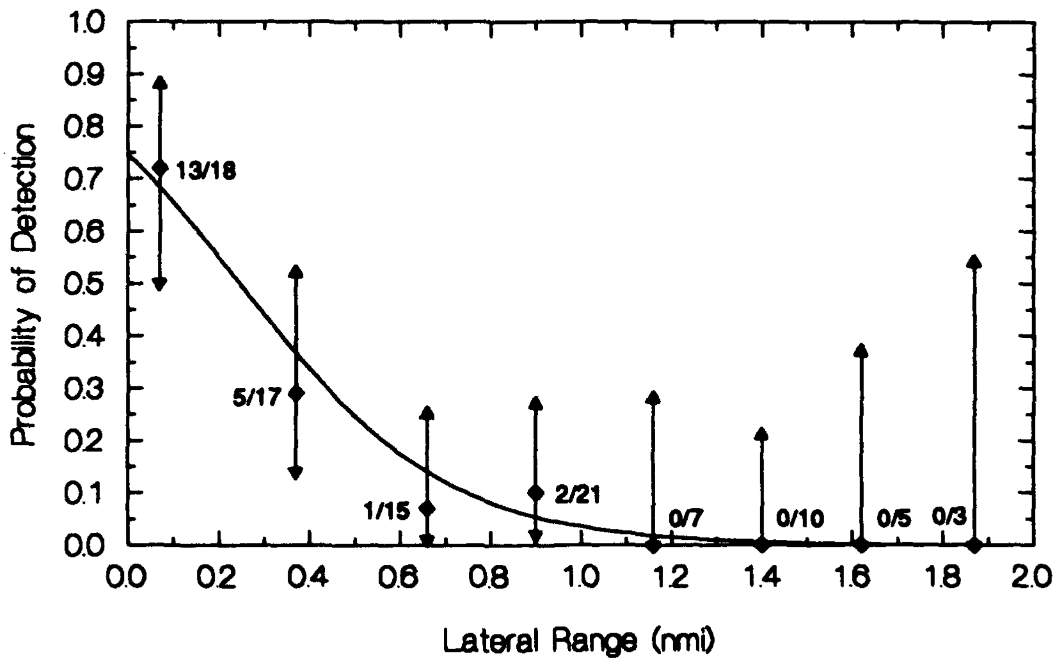


Figure 2-2. Helicopter Detection of Life Rafts Without Retroreflective Tape (moon visible, H_S > 2.5 feet)

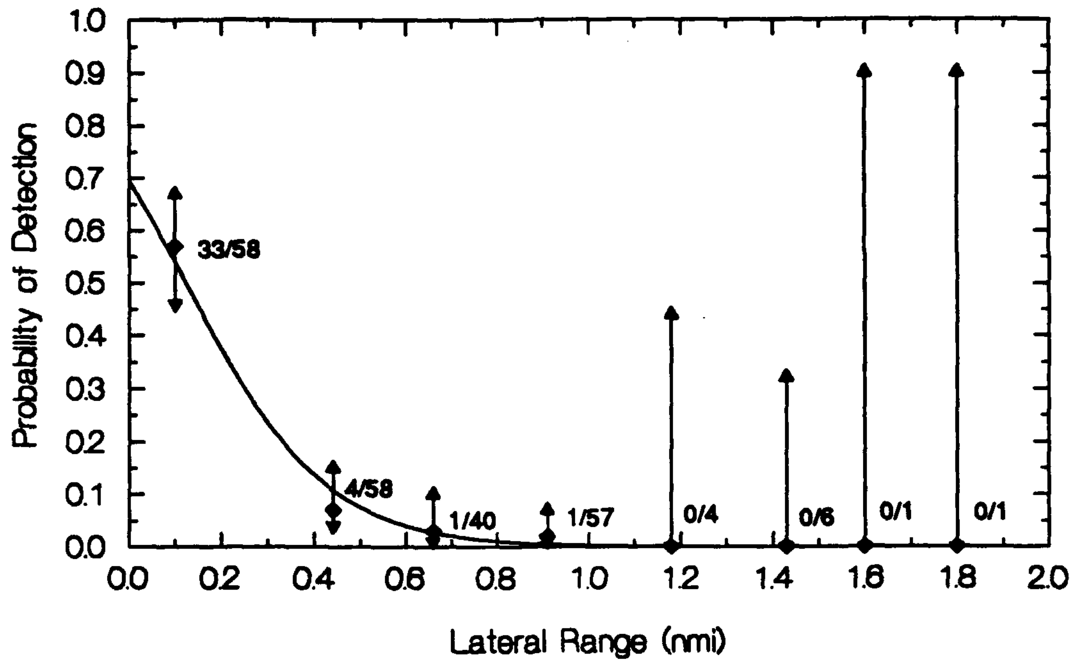


Figure 2-3. Helicopter Detection of Life Rafts Without Retroreflective Tape (moon not visible)

2.2.1.2 Life Raft Targets With Retroreflective Tape

One hundred data points have been collected for this SRU/target type combination. Of these, only 7 occurred in moonlit conditions; thus the effect of the moon visibility parameter could not be evaluated for this SRU/target type combination. LOGIT regression analysis indicated that variation in target detection probability within this data set could best be explained at the 90-percent confidence level by a combination of the lateral range and whitecap parameters.

An interesting characteristic of this data set is that the portion obtained during the spring 1990 experiment was collected in a fairly large swell (H_S from 3 to 4.3 feet) with no whitecaps, and the portion obtained during the fall 1990 experiment was collected in lower, wind driven, waves (H_S from 1.6 to 2.6 feet) with over half the target detection opportunities occurring when whitecaps were present. When the combined data set was analyzed, higher H_S values appeared to provide a higher detection probability than lower H_S values. This result is contrary to both common sense expectations and to analysis results found in other SRU/target type data sets. The association of whitecaps with the lower H_S values helps explain why this apparent reversal in the effect of H_S occured. When a whitecap parameter was substituted for H_S in the LOGIT function, a sensible regression fit to the data was obtained.

After LOGIT analysis, the data were first sorted into two subsets representing the no-whitecaps (72 observations) or whitecaps-present (28 observations) conditions. These data subsets were each sorted into four, 0.25 nmi lateral range bins from 0.0 to 1.0 nmi. The data set with whitecaps present (figure 2-4) gives a good indication that beyond 0.25 nmi probability of detection is reduced drastically but has insufficient data to support generation of a LOGIT-fitted lateral range curve or sweep width estimate. Figure 2-5 depicts the probability of detection vs. lateral range relationship for the data set with no whitecaps. As may be seen, target detection probability remains close to or above 50 percent out to distances of 0.75 nmi. A sweep width estimate of 0.95-nmi for the data set without whitecaps was obtained by integrating the fitted LOGIT probability equation over the limits of 0.0 to 2.0 nmi.

2.2.1.3 Small Boat Targets

During the fall 1990 experiment, 238 target detection opportunities, all in moonlit conditions, were added to this data set. LOGIT regression analysis on the full data set at the 90-percent confidence level indicated that variations in target detection probability within the

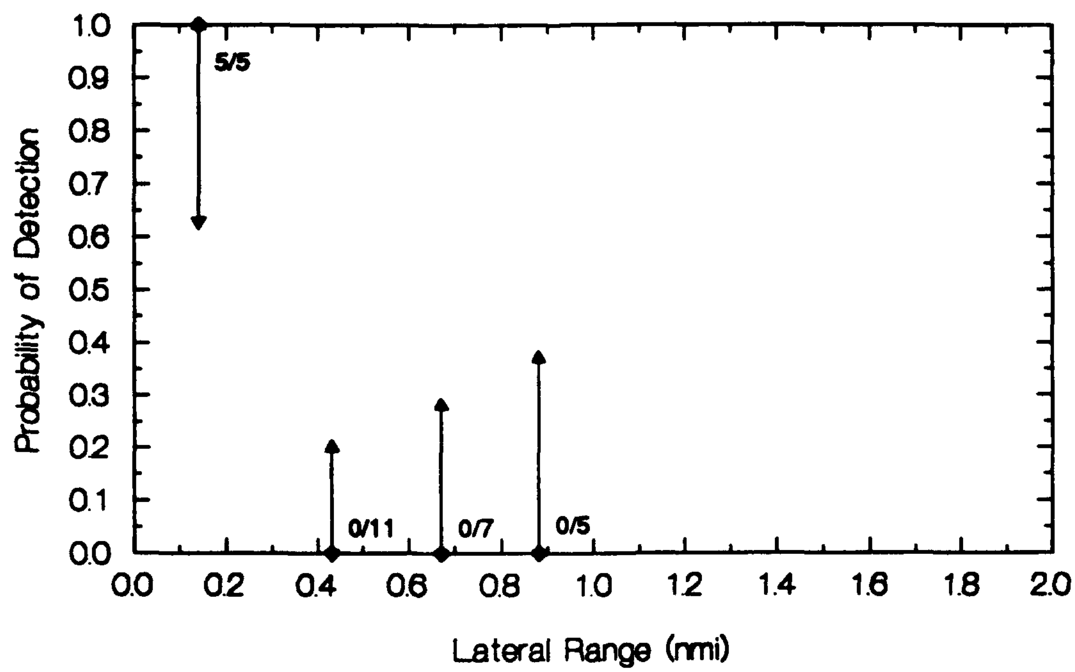


Figure 2-4. Helicopter Detection of Life Rafts With Retroreflective Tape
(whitecaps present)

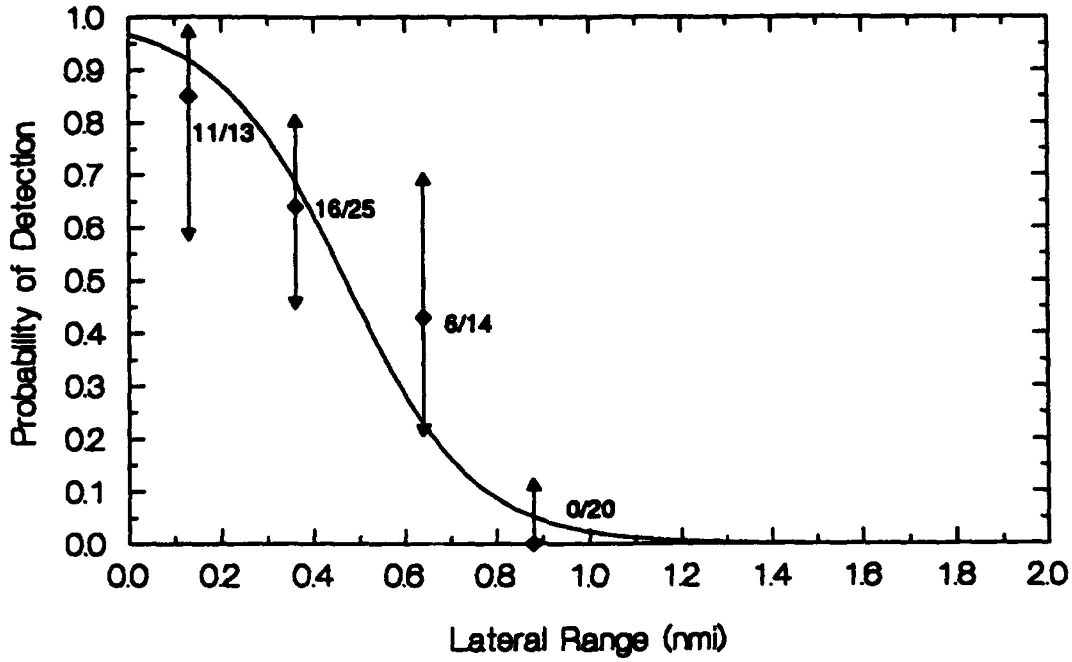


Figure 2-5. Helicopter Detection of Life Rafts With Retroreflective Tape
(no whitecaps present)

helicopter/small boat data set could best be explained by a combination of the lateral range and moon visibility parameters. Within the moonlit data subset, a separate LOGIT analysis at the 90-percent confidence level showed that H_S and visibility also exerted significant influence on target detection probability. The analysis of data presented in reference 2 identified the same four significant parameters listed above, only the non-moonlit data subset was not separately analyzed in that report. Using an approach of analyzing the moonlit and non-moonlit data subsets separately, the number of distinct sets of search conditions requiring lateral range curve fits was reduced from six in reference 2 to three here. For searches in moonlit conditions with H_S from 1.6 to 2.3 feet and visibility from 7 to 15 nmi, 173 target detection opportunities exist, for searches conducted in moonlit conditions with H_S from 2.6 to 4.3 feet and visibility from 6 to 15 nmi, 165 opportunities exist, and for searches performed when there was no moon light present, 232 opportunities exist.

Figures 2-6, 2-7, and 2-8 show the raw data plots for these three sets of search conditions. The raw data were sorted into eight, 0.25-nmi lateral range bins from 0 to 2 nmi and four, 0.5-nmi lateral range bins from 2.0 to 4.0 nmi. The LOGIT-fitted lateral range curves plotted in figures 2-6, 2-7, and 2-8 were produced by solving separate LOGIT regression model equations using the

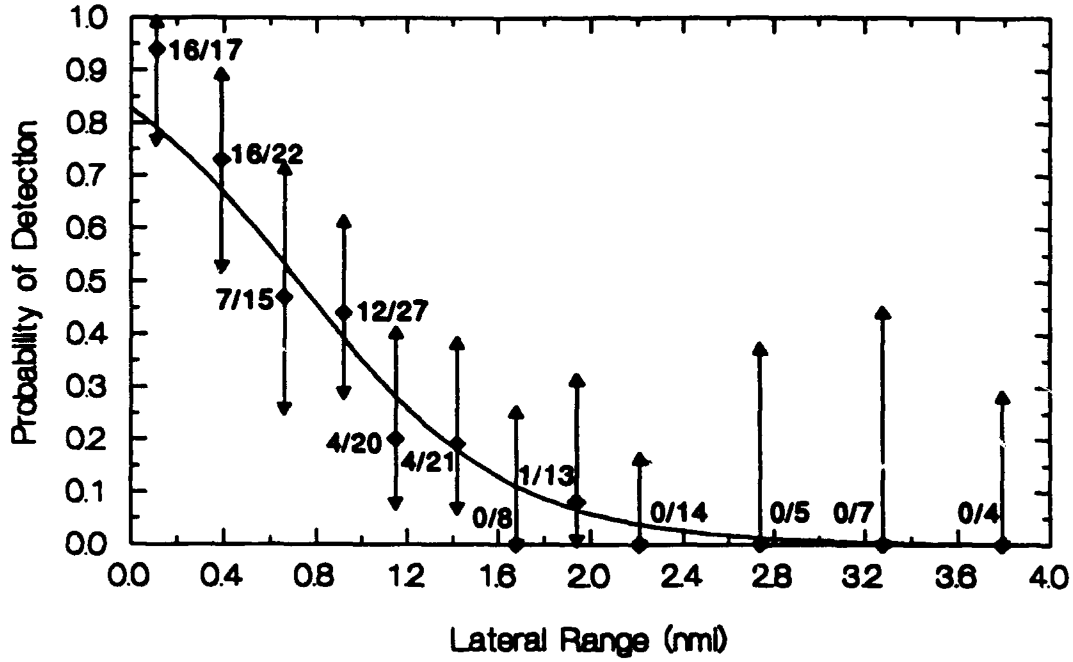


Figure 2-6. Helicopter Detection of 18- and 21-foot Boats
(moon visible, H_S = 1.6 to 2.3 feet, visibility = 7 to 15 nmi)

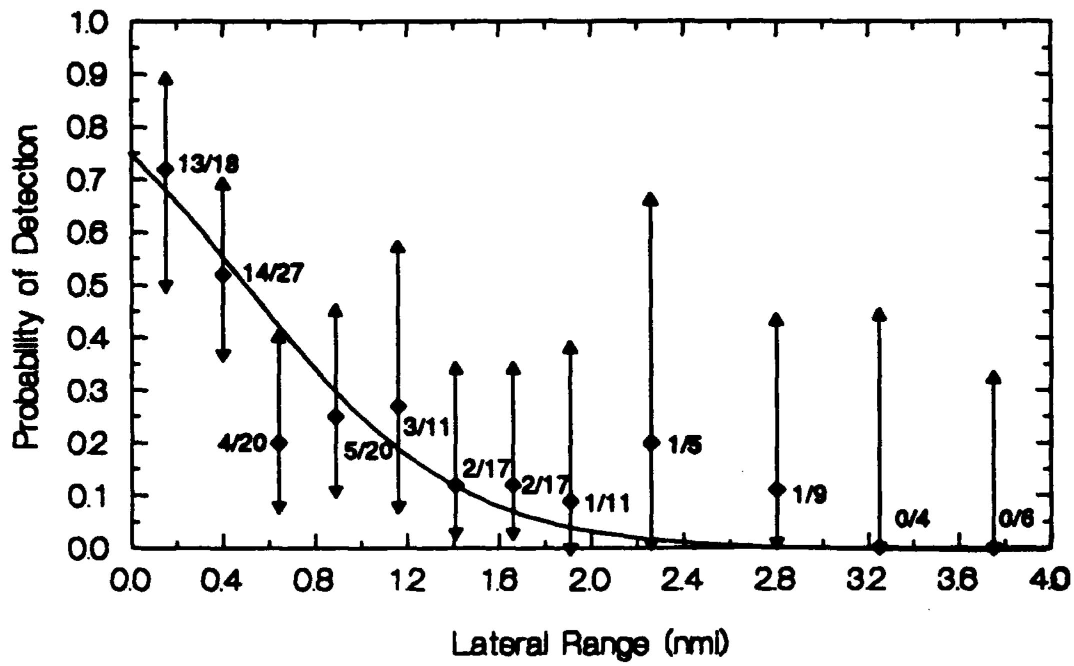


Figure 2-7. Helicopter Detection of 18- and 21-foot Boats
(moon visible, H_S = 2.6 to 4.3 feet, visibility = 6 to 15 nmi)

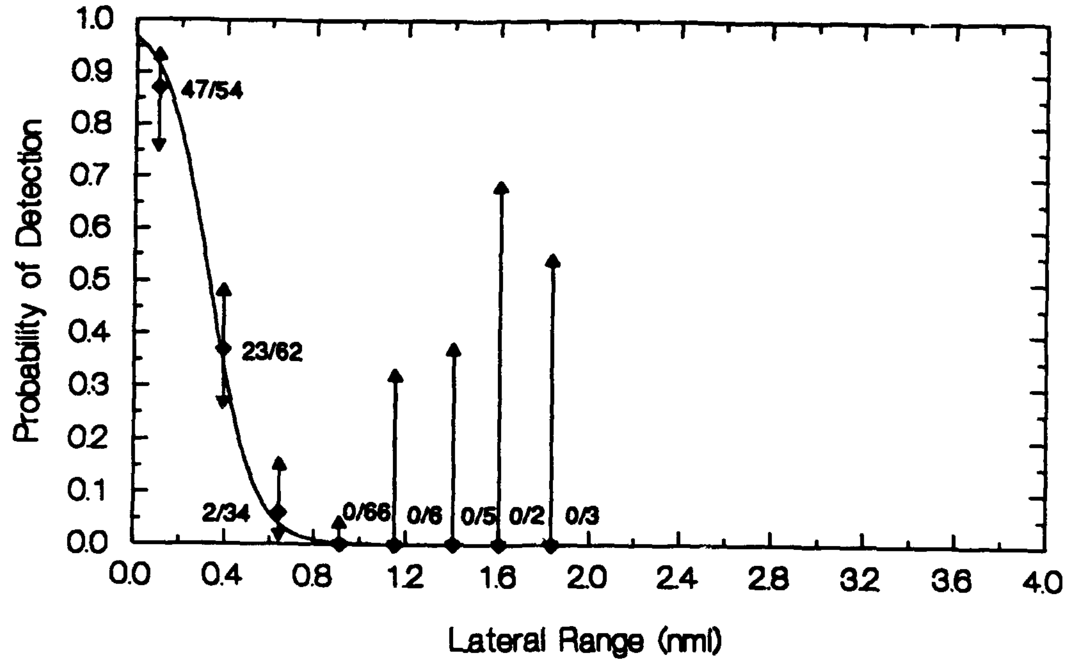


Figure 2-8. Helicopter Detection of 18- and 21-foot Boats
(moon not visible)

applicable moon conditions, the average values of H_S and visibility (moonlit data only), and lateral range values from 0.0-to 4.0-nmi as inputs. Sweep width estimates were obtained by integrating the fitted LOGIT probability equations over the limits of 0 to 4 nmi. The resultant sweep width estimates were 1.61 nmi, 1.29 nmi, and 0.66 nmi for figures 2-6 through 2-8, respectively.

2.2.2 UTB Detection Performance

2.2.2.1 Life Raft Targets Without Retroreflective Tape

Twenty new target detection opportunities were added to this data set during the fall 1990 experiment. All twenty opportunities occurred in moonlit conditions. LOGIT regression analysis of the updated data set at the 90-percent confidence level indicated that variation in target detection probability could best be explained by a combination of the moon visibility and lateral range parameters.

probability could best be explained by a combination of the moon visibility and lateral range parameters.

Figures 2-9 and 2-10 provide raw data plots and LOGIT-fitted lateral range curves for the moonlit and moonless search conditions, respectively. The raw data plots were generated by first sorting the detection opportunities into moonlit and non-moonlit data sets, then sorting those into five, 0.2-nmi lateral range bins from 0 to 1 nmi. The fitted lateral range curves were produced by solving the LOGIT regression model equation using the appropriate value of the moon visibility parameter and lateral ranges from 0 to 1 nmi as inputs.

Sweep width estimates were obtained by integrating the fitted LOGIT probability equation over the limits of 0.0-to 1.0-nmi. The resultant sweep width estimates were 0.55-nmi for figure 2-9 and 0.17-nmi for figure 2-10. The reader is cautioned that, because only 33 detection opportunities exist for the moonlit condition, the lateral range curve and sweep width estimate given for the data in figure 2-9 should be considered tentative.

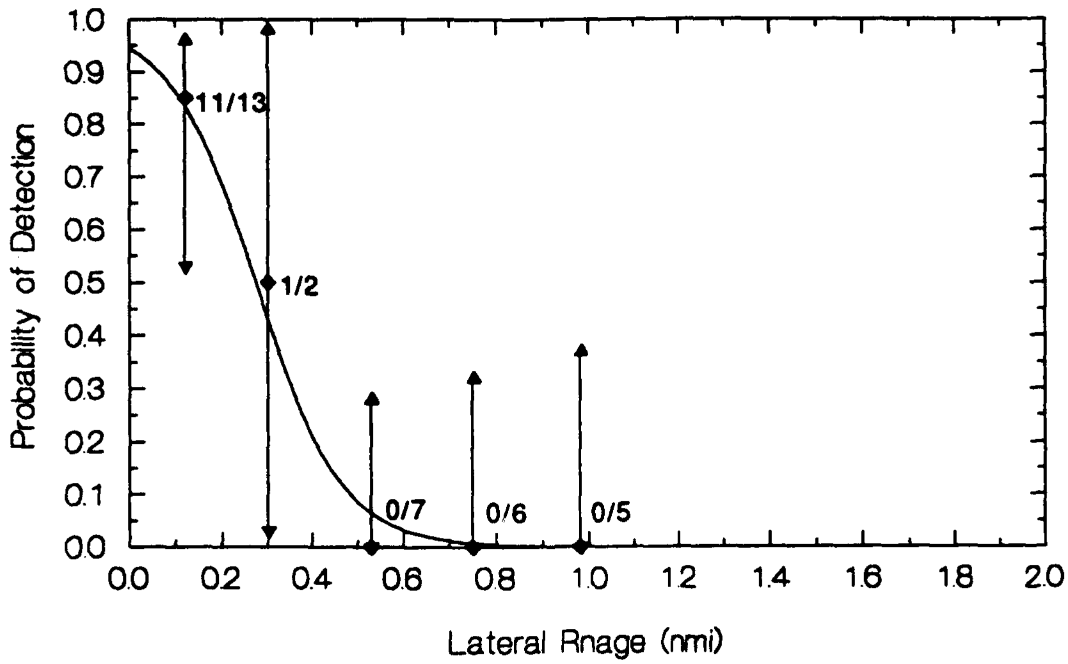


Figure 2-9. UTB Detection of Life Rafts Without Retroreflective Tape (moon visible)

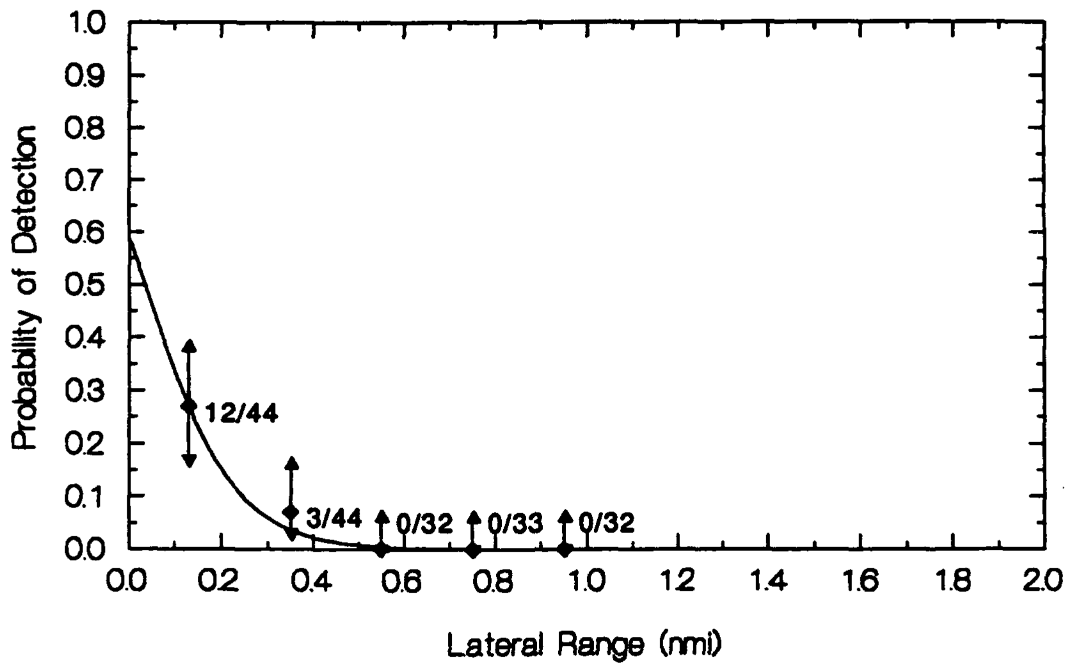


Figure 2-10. UTB Detection of Life Rafts Without Retroreflective Tape (moon not visible)

2.2.2.2 Life Raft Targets With Retroreflective Tape

A total of 135 target detection opportunities were obtained for this SRU/target type combination. LOGIT regression analysis indicated that variation in target detection probability within this data set could best be explained at the 90-percent confidence level by the lateral range parameter alone.

After LOGIT analysis, the data were sorted into five, 0.2-nmi lateral range bins from 0.0 to 1.0 nmi. The fitted lateral range curve in figure 2-11 was produced by solving the LOGIT regression model equation for lateral ranges from 0.0 to 1.0 nmi. A sweep width estimate of 0.17-nmi was obtained by integrating the fitted lateral range probability equation over the limits of 0.0 to 2.0 nmi.

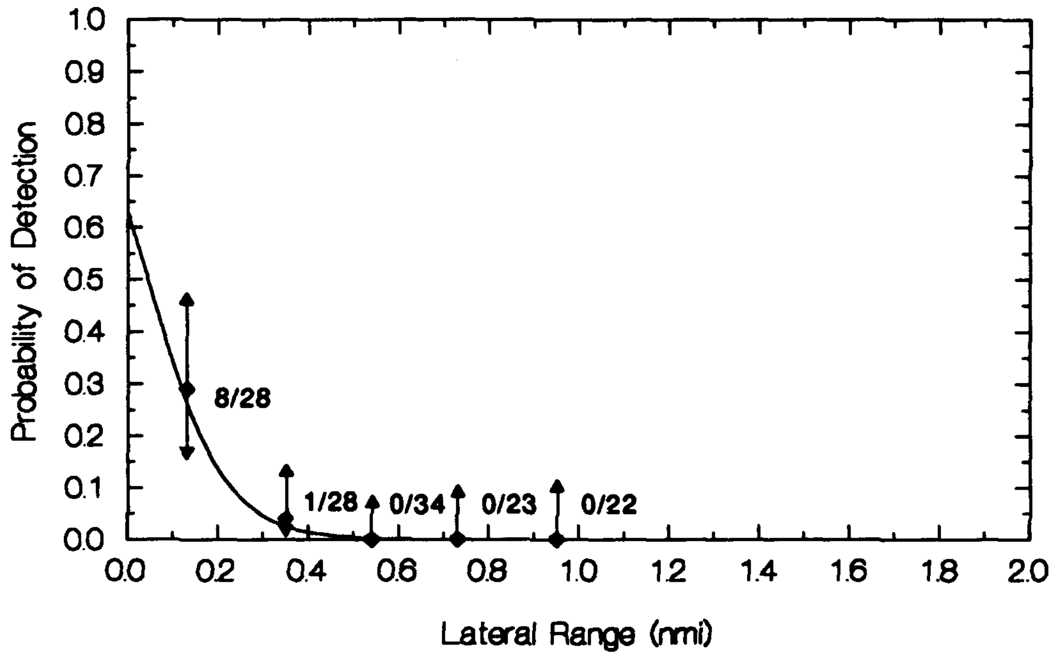


Figure 2-11. UTB Detection of Life Rafts With Retroreflective Tape

2.2.2.3 Small Boat Targets

LOGIT regression analysis at the 90-percent confidence level indicated that variations in target detection probability within the UTB/small boat data set could best be explained by a combination of the lateral range, H_S, and boat size (subtype) parameters. The 194 detection opportunities in this data set were initially sorted into four subsets based on the H_S and subtype parameters. The initial data sort yielded 40 detection opportunities for 18-foot boats in 1.3-to 2.0-foot seas, 34 detection opportunities for 21-foot boats in 1.3-to 2.0-foot seas, 69 detection opportunities for 18-foot boats in 2.3-to 4.3-foot seas, and 51 detection opportunities for 21-foot boats in 2.3-to 3.9-foot seas. Each of these data groups was then sorted into five, 0.20-nmi lateral range bins from 0 to 1.0 nmi and one lateral range bin from 1.0 to 2.0 nmi. These data are plotted in figures 2-12 through 2-15.

The LOGIT-fitted lateral range curves in figures 2-12 through 2-15 were produced by solving the LOGIT regression model equation for the appropriate boat type, the average value of H_S in each data subset, and for lateral ranges of 0 to 2.0 nmi. Sweep width estimates were obtained by integrating the four fitted LOGIT probability equations over the limits 0 to 2.0 nmi. The resultant sweep width estimates were 0.24 nmi for figure 2-12, 0.49 nmi for figure 2-13, 0.12-nmi for figure 2-14, and 0.32 nmi for figure 2-15.

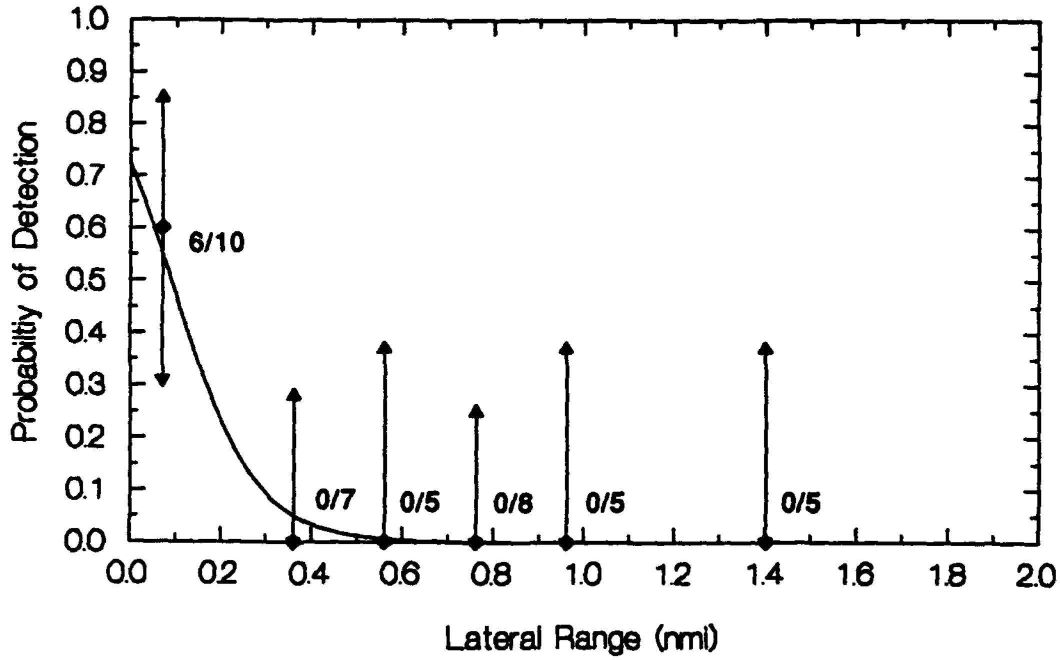


Figure 2-12. UTB Detection of 18-foot Boats
(H_S from 1.3 to 2.0 feet)

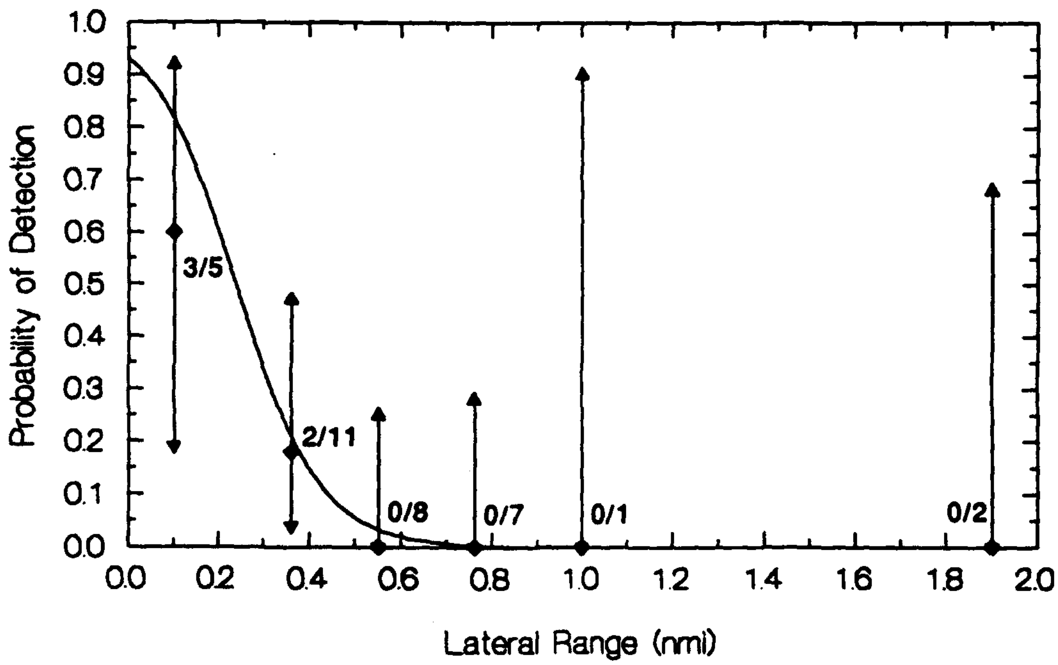


Figure 2-13. UTB Detection of 21-foot Boats
(H_S from 1.3 to 2.0 feet)

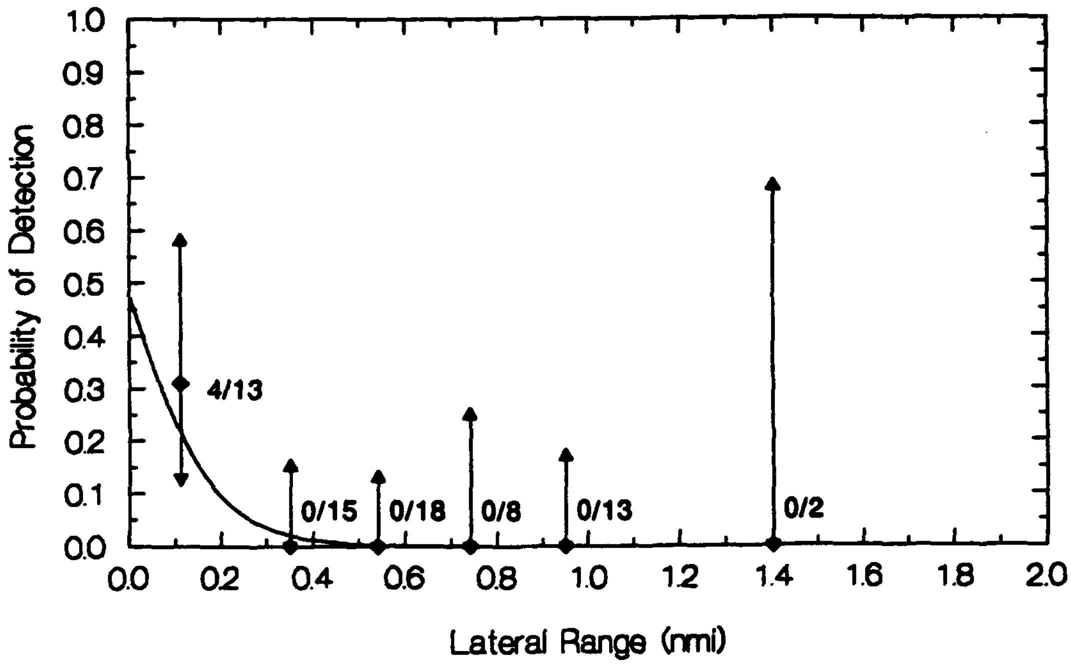


Figure 2-14. UTB Detection of 18-foot Boats
(H_S from 2.3 to 4.3 feet)

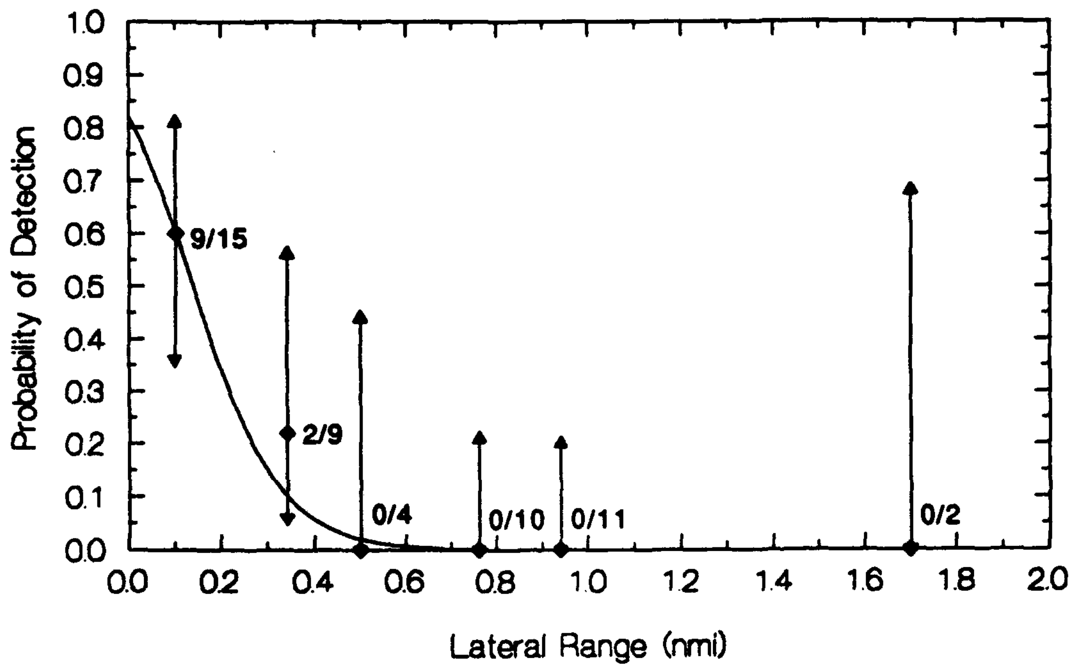


Figure 2-15. UTB Detection of 21-foot Boats
(H_S from 2.3 to 3.9 feet)

2.3 HUMAN FACTORS

The next three sections provide information that relates to the human factors aspects of conducting NVG-assisted searches in the marine environment. Section 2.3.1 provides quantitative data on where and from what crew positions NVG detections were made. Sections 2.3.2 and 2.3.3 summarize subjective comments and observations made by the SRU crews and members of the R&D Center test team.

2.3.1 Analysis of Detection by Position

Figure 2-16 depicts the distribution of the target detections made by helicopter SRUs. This information is provided by target type in the first three diagram pairs and for all helicopter detections combined in the fourth diagram pair. The circular diagrams on the left side of figure 2-16 show the distribution of initial target detections as a function of relative bearing (expressed in "clock" format). This information is independent of which crew position actually made the detection. The silhouette diagrams on the right side of figure 2-16 show the distribution of initial target detections as a function of the five crew positions onboard the HH-3 and CH-3 helicopters. The information in the silhouette diagrams is independent of the clock bearings at which the targets were initially sighted.

The information in figure 2-16 shows that the copilot position (left seat) made more detections than the pilot position (right seat) for all data sets. This occurred even though the two pilots usually switched seats between sorties or on alternate nights. The difference in the number of detections made by the two pilot positions is consistent across all four target types, and suggests a degradation in search capability that results from constant scan-shifting by the pilot between NVGs outside the cockpit and unaided vision inside the cockpit. This difference in detection performance might have been more pronounced except that during many searches, the aircraft was flown from the copilot seat for significant periods of time.

In the aft section of the helicopter, the flight mechanic, who usually searches through an open door with a wide field of view and no glass to reflect light, made more detections overall than either the rescue swimmer position or the avionics position. The rescue swimmer position, which was not equipped with a seat on two of the four test helicopters, made substantially fewer initial

detections than any other crew position. The swimmer confirmed many detections, but was first to see only those 24 listed.

The clock-bearing data in figure 2-16 indicate that most helicopter detections were made between 9 and 11 o'clock on the port side and between 1 and 3 o'clock on the starboard side. A pronounced dip in detections consistently occurred dead-ahead of the aircraft. This reflects the short range at which most NVG detections are made. The aircraft nose inhibits the close in detection capability at 12 o'clock.

Figure 2-17 depicts the distribution of detections for UTB SRUs. Unlike the helicopters, not all crew positions depicted on the UTB silhouette diagrams were always manned. The UTBs typically searched with two NVG-equipped lookouts who positioned themselves on the port and starboard bow when seas were calm and the weather was warm. When spray and/or cold wind was prevalent, the lookouts took shelter behind the wheelhouse at the port and starboard aft positions. The forward and aft center positions were seldom manned unless three or more NVG-equipped lookouts were available or only a single lookout was searching with NVG. All helm detections were made with the naked eye.

The clock-bearing data in figure 2-17 indicate that most UTB detections were made between 9 and 10 o'clock on the port side and between 2 and 3 o'clock on the starboard side. A comparison of the composite clock bearing and silhouette data indicates that the starboard aft lookouts made more detections than the port aft lookouts. This may be because the cabin door is directly adjacent to the port aft lookout position. The open door may have allowed more light to interfere with NVG operation and more distraction of the port aft lookout due to conversations with personnel inside the wheelhouse.

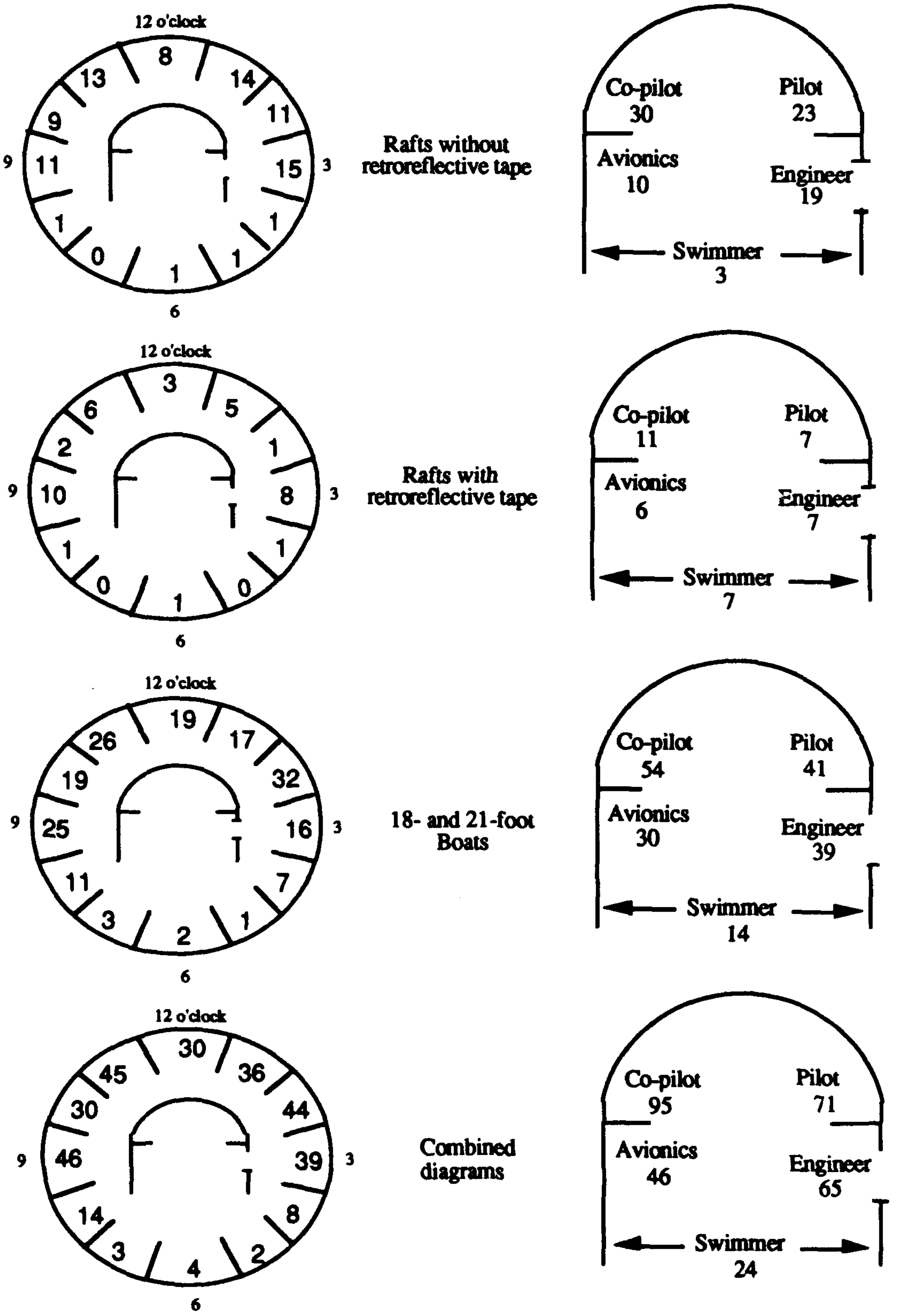


Figure 2-16. Distribution of Helicopter Detections by Clock Bearing and Crew Position

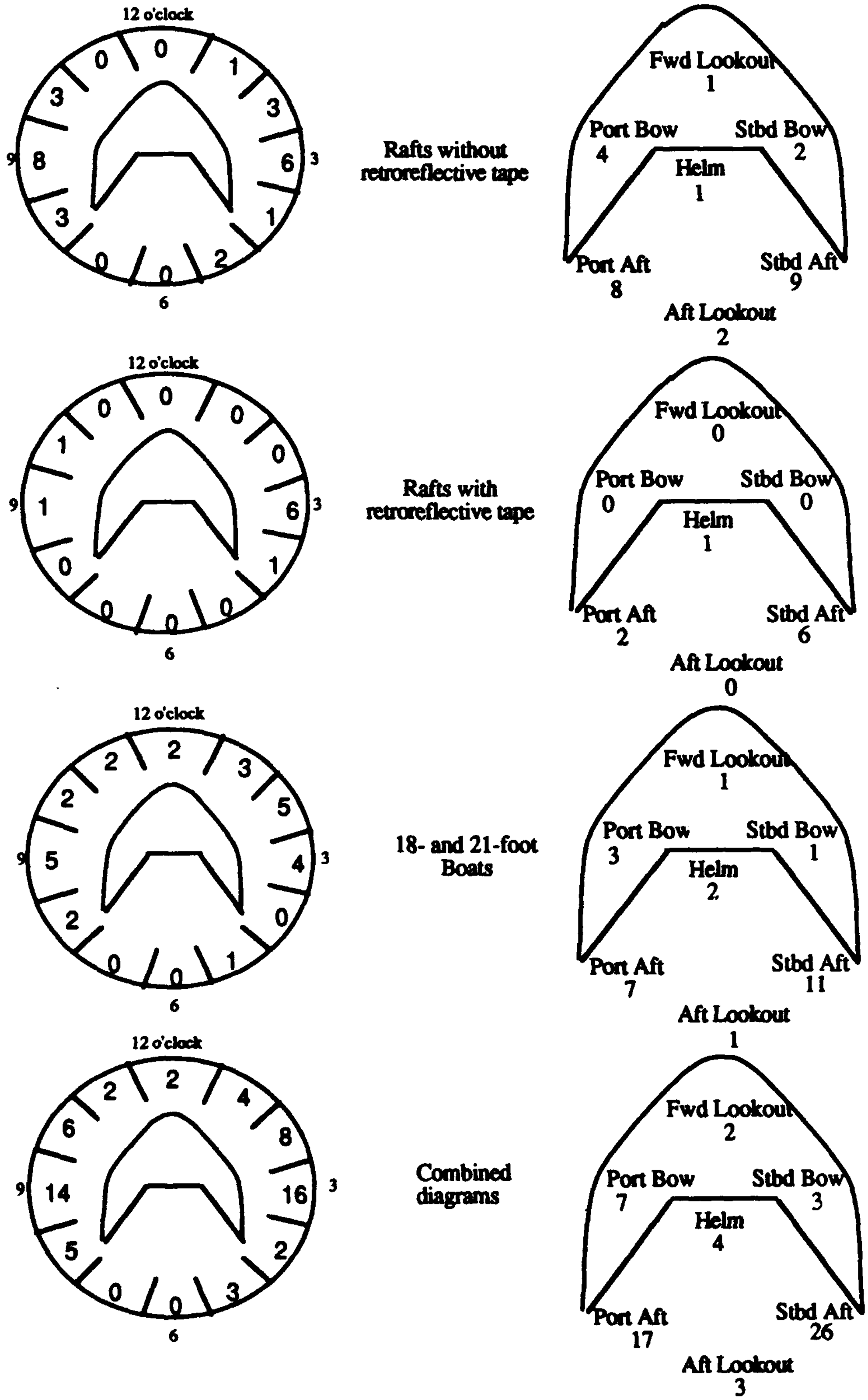


Figure 2-17. Distribution of UTB Detections by Clock Bearing and Crew Position

2.3.2 SRU Crew Comments Concerning NVG Use and Target Appearance

Subjective comments from the SRU crews concerning the comfort, ease-of-use, and effectiveness of the NVGs and their suitability for Coast Guard SAR operations were solicited each night by the data recorders. References 7 through 10 contain verbatim lists of the comments received during the five NVG experiments conducted to date. A condensed summation of these comments is provided below.

2.3.2.1 Crew Comments Concerning NVG Use

Helicopter Crews

1. Moon light generally enhanced the lookouts' ability to detect targets at greater lateral ranges, however, looking into a low moon inhibited the lookouts' ability to detect any target.

2. A clear bright moon can over drive the goggle tubes to the point that the automatic shut down circuit will activate to prevent damage to the photo-reactive tube layers and the goggles will cut out. Even a partial moon can be a blinding light source when viewed through the NVGs. This is usually solved by not gazing towards such bright lights.

3. When light sources from inside or outside the helicopter shine on the inside window surfaces, glare can become a problem for the NVG equipped lookout. Perhaps the inside surfaces of the windows should be coated with anti-glare materials much like the outside of the windows.

4. In periods of low ambient light, there was difficulty seeing outside the helicopter. The NVG display was black or grainy and the instruments created too much glare on the windows. Also, outside the aircraft, the rotating beacon became more visible. This was more of a problem in fog or haze than on clear nights. On a clear night, the rotating beacon or search light can help illuminate targets.

5. Complaints of eye strain were common, especially after long sorties. Even 5-minute breaks seemed to help. Also, as the searches progressed, crews reported that goggle focus appeared to wander. After several hours, many crew members reported being unable to bring the NVGs back into focus.

6. Crews that were given the opportunity to view a target with the NVGs before commencing searches felt that it was helpful in familiarizing them with what to look for.

7. Some crews felt that it was helpful to fly near the shoreline and refocus the NVGs between searches.

8. One crew felt that a counterweight is needed on the back of the helmet to offset the goggle weight. The battery pack that now exists does not provide the appropriate weight. Another crew regularly used velcro-attached weights on the back of the helmet to offset the goggle weight.

10. Rough seas make it difficult to distinguish targets from waves/white caps.

<u>UTB Crews</u>

1. Goggles were easier to focus in good light conditions, the visual presentation was better, and it was easier to maintain concentration. Lookouts found that, in lower light levels, concentrating on whitecaps helped keep them from simply staring at the display lens.

2. On bright, moonlit nights there almost seemed to be too much light for the goggles.

3. Searching during a lightning storm is very difficult because the lightning blinds the goggle wearer even more so than a naked eye searcher.

4. Coxswains and helmsmen preferred not using NVGs because they felt it interfered with their job of navigating the boat. Some coxswains felt that keeping a pair of NVGs at hand to check lookout reports was a good idea while others felt that the goggles didn't provide any more information than radar.

5. There were many variations of "my eyes are tired." Typically after an hour, lookouts reported tired/sore/watery eyes and after about two hours, they reported headaches and disorientation. Short breaks and lookout rotation appeared to help alleviate some of these problems.

6. Some lookouts, even those not normally prone to it, became seasick very easily while using NVGs. This occurred more often as seas became rougher and occasionally UTBs returned to port because of crew seasickness.

7. There were many complaints that the PVS-5 and PVS-7 head gear was very uncomfortable and that the goggles pressed on the face, but later in the searches, there were fewer complaints of this nature. Some crews chose not to wear the headset and held the goggles as they would binoculars. When crews took their time and adjusted the headset straps to relieve some of the facial pressure, they grew tired more slowly and there were fewer complaints of headaches.

8. Looking at brighter shore lights reduced the effectiveness of the goggles. Often these lights would obscure up to half the distance from the horizon.

9. When sea conditions and sea spray forced lookouts behind the pilot house, the intensity of the running lights or stern light and their glare obscured or partially obscured the view through the NVGs. This left a fairly narrow sector abeam for effective searching. One crew secured the running lights and eliminated this problem.

10. Lighted objects could be easily seen on clear nights even when not visible to the naked eye.

11. Crews that were given the opportunity to view a target with the NVG before commencing searches felt that it helped them by familiarizing them with the target appearance.

12. Plenty of lens cleaning paper was needed when spray or precipitation was present. Frequent breaks should be taken to rest eyes and clean lenses.

13. Some coxswains felt what was really needed was a better radar.

2.3.2.2 Crew Comments Concerning Target Appearance

SRU crew members were encouraged to provide descriptions of target appearance when detections were made. These target descriptions are listed in table 2-2 by SRU and target type. The descriptions appear in the table in descending order of frequency for each SRU/target type combination.

Table 2-2. Summary of Target Appearance Descriptions

TARGET TYPE	SEARCH UNIT TYPE	
	HELICOPTER	UTB
Boats	Bright/white/light Boat/Skiff Open white boat Black/dark/dark w/canvas Boat w/canvas White w/dark bottom	Boat/skiff Bright/white/light Boat w/console Boat w/canvas Black/dark Could not tell/something Greenish
Rafts without retroreflective tape	Raft Bright/white/light Light w/dark bottom Black/dark w/white top Black w/white reflection off anti-collision light	Raft Black Light w/dark bottom Bright/white/light blob Round-grey black
Rafts with retroreflective tape	White/light Raft with tape Flashing with aircraft beacon Flashing triangle Glowing object	Raft with tape, bright top Ball of light/white Dark object Top of a raft

2.3.3 Test Team Observations Concerning NVG Use

Data recorders who accompanied the SRU crews on the NVG searches logged subjective comments as time and opportunity permitted. These comments were sometimes similar in nature to comments received directly from the SRU crews, but were made from a third-party viewpoint

while not directly involved in the NVG search task. All data recorders were familiar with NVG characteristics and principles of operation. Some of the data recorders also had at least an hour or two of experience using the NVGs while underway onboard an SRU or a workboat. Data recorder comments are summarized below.

Helicopter Observations

1. Cockpit workload drew the pilot and/or copilot off NVGs frequently for communications, instrument scans and navigation computer adjustments. These distractions were usually brief, but occurred frequently. Coverage of the search area with NVGs was probably less thorough than with daytime visual search due to this frequent scan shifting without benefit of peripheral vision outside the cockpit.

2. NVG training seems to vary between air stations. Some crews spent time adjusting and focusing goggles prior to take off while others would focus after takeoff. Most crews maintained good scanning techniques until late in the sortie.

3. Helicopter crew members, particularly those at the pilot, co-pilot and avionics positions, noticed glare from light shinning off the inside of the windows. Whether the light source was from inside the helicopter or external light shining into the helicopter, it hampered NVG search efforts.

4. Moon light greatly improved the NVG image clarity and horizon definition. Increased aircrew enthusiasm was evident under these conditions. Some crews actually transited to and from the search area at 300 feet to enable them to see objects as they would during the search.

UTB Observations

1. Weather and sea conditions greatly affected searcher attitudes onboard the UTBs. Moderate sea sweil or wind chop and/or poor ambient light brought on frequent instances of seasickness and lack of enthusiasm for NVG use among the crews. Several crews were very positive about NVG testing when calm seas and good ambient light prevailed.

2. UTB crews consistently complained about soreness in their eyes and headaches when using the NVGs and some crews began experimenting with ways of relieving eye strain. These included using the goggles in a hand-held mode and occasionally searching without NVGs, sitting on the deck and supporting the goggles with their hands, laying on the deck, and taking frequent short breaks. These methods appeared to ease crew discomfort somewhat.

3. Some nights radar detected targets that could be found with a search light but not with goggles. Even when NVG-equipped lookouts were notified that radar had a target in a certain area, they often were unable to locate it whereas the coxswain using the search light could. (The majority of this type of incident occurred on darker nights when NVG performance was marginal.)

4. Boat crews achieved consistently poorer detection results than did helicopter crews. This lack of success with the NVGs was reflected in crew attitudes and motivation during the later stages of the experiments.

5. The level of the UTB crews' knowledge and training relative to the use and care of the NVG systems was much more varied than that of the helicopter crews. Many crews had virtually no training at all prior to participating in the experiments.

6. UTB crews would likely benefit from a helmet-mounted NVG arrangement that allows non-NVG peripheral vision and provides for flipping the goggles up and away from the face while performing engineering checks, navigation chores, radar scans, and other non-search duties.

CHAPTER 3
CONCLUSIONS AND RECOMMENDATIONS

3.1 CONCLUSIONS

The following conclusions are based on the quantitative data analyses and subjective comments provided in chapter 2. The conclusions address new findings only. Additional conclusions based on earlier NVG experiments can be found in chapter 3 of references 1 and 2.

3.1.1 Search Performance of NVG-Equipped Helicopters

1. The presence of a visible moon significantly improves ANVIS detection performance (as measured by sweep width) against both life raft targets without retroreflective tape and small boat targets. The sweep width obtained in the non-moonlit conditions data subset was half that in the moonlit conditions data subset with the higher observed H_S and was nearly a third of that in the moonlit data subset with the lower observed H_S.

2. Analysis of limited data indicates that the addition of retroreflective tape to life rafts in accordance with SOLAS specifications may improve their detectability (as measured by sweep width) by the ANVIS goggles. Results to date are tentative because they are based primarily on data collected in moonless conditions.

3.1.2 Search Performance of NVG-Equipped UTBs

1. The presence of a visible moon appears to significantly enhance UTB detection performance (as measured by sweep width) against life rafts without retroreflective tape. Additional data collected in moonlit conditions would improve confidence in the magnitude of this improvement in sweep width.

2. With the small boat targets, UTB detection performance varied with H_S and target boat size. Sweep width was approximately one-tenth of comparable daytime visual search values against open, 18-foot targets and about one-fifth of the daytime values against 21-foot targets with canvas.

3. The addition of retroreflective tape to 4-and 6-person life rafts does not appear to improve their detectability by NVG-equipped UTBs.

4. UTBs have a very low detection level for all target types when searching with NVGs.

3.1.3 General Conclusions

1. The presence of a visible moon significantly enhances the ability of NVG-equipped SRUs to detect small search targets that are not equipped with lights.

3.2 RECOMMENDATIONS

The following interim recommendations are added to those already provided in references 1 and 2. These recommendations are based on new information obtained during the fall 1990 NVG test.

Daylight visual sweep widths referenced in sections 3.2.1 and 3.2.2 are tabulated in reference 11. Fatigue, weather, and speed corrections listed in reference 11 are not to be applied unless specified below.

3.2.1 NVG Searches With Helicopters

1. The following sweep width estimates should be used when the search object is a 4- or 6-person life raft without retroreflective tape.

   moon visible in search area - multiply the daylight visual sweep width, corrected for weather only, by 0.5.
   moon not visible in search area - multiply the daylight visual sweep width, corrected for weather only, by 0.3.

2. The following sweep width estimates should be used when the search object is a small (15-to 25-foot) boat target.

moon visible in search area and

H_S less than or equal to 2.5 feet - multiply the uncorrected daylight visual sweep width by 0.3.

H_S from 2.5 to 4.3 feet - multiply the uncorrected daylight visual sweep width by 0.25.

moon not visible in search area - multiply the uncorrected daylight visual sweep width by 0.15.

3. The following sweep width estimates should be used when the search object is a 4-or 6-person life raft with retroreflective tape.

no whitecaps visible in search area - multiply the uncorrected daylight visual sweep width by 0.4.

3.2.2 NVG Searches With UTBs

1. UTBs should not be outfitted with NVGs solely for the purpose of conducting nighttime search missions.

2. The following guidelines should be used when estimating sweep width for 4-to 6-person life raft targets without retroreflective tape.

moon visible in search area - multiply the uncorrected daylight visual sweep width by 0.16.
moon not visible in search area - multiply the uncorrected daylight visual sweep width by 0.05.

3. The following sweep width estimates should be used when the search object is a small boat target.

18-foot open boat target - multiply the daylight visual sweep width, corrected for weather only, by 0.07.

21-foot boat target with cabin or canvas shelter - multiply the daylight visual sweep width, corrected for weather only, by 0.17.

4. Sweep width for 4- or 6-person life rafts with retroreflective tape applied per SOLAS specifications should be estimated by multiplying the uncorrected daylight visual sweep width by 0.05.

3.2.3 Recommendations For Future Research

1. Data collection priorities for future NVG tests are listed below in descending order of preference.

   - PIW targets without lights in moonlit conditions,
   - raft targets with retroreflective tape in moonlit conditions,
   - red safety lights in moonlit conditions (helicopter) or all conditions (UTB).

2. The HH-65A and HH-60J Coast Guard helicopters should be evaluated for their NVG search performance. Onboard the HH-3 and CH-3 helicopters evaluated in this study, the 3 crew positions aft of the cockpit made more than 43 percent of all initial target sightings. Since the HH-65A and HH-60J carry smaller crews, it is possible that their NVG detection performance will not be as good as that reported here. Any performance differences should be identified and quantified to ensure that accurate sweep widths are available for these newer aircraft.

3. More NVG search performance data should be collected in moonlit conditions. Data for clear, calm, moonlit conditions and helicopters searching for life rafts with retroreflective tape are especially lacking in the existing NVG data base.

4. Sources of NVG-compatible illumination should be evaluated on surface and air SRUs, particularly against targets that are not equipped with lights. These targets should include both retroreflective and non-retroreflective materials.

5. Larger surface SRUs (such as WPBs and WMECs) should be evaluated for their NVG search performance.

REFERENCES

1. Reynolds, W.H.E.; Robe, R.Q.; Hover, G.L.; and Plourde, J.V., Evaluation of Night Vision Goggles for Maritime Search and Rescue, Interim Report, Coast Guard R&D Center and A&T, Inc. April 1990.

2. Reynolds, W.H.E.; Robe, R.Q.; Hover, G.L.; and Plourde, J.V., Evaluation of Night Vision Goggles for Maritime Search and Rescue, Interim Report, Coast Guard R&D Center and A&T, Inc. August 1990.

3. Aviator's Night Vision Imaging System, ITT Electro-Optical Products Division informational brochure, 1986.

4. ITT Achieves Leadership in Night Vision Technology, ITT Electro-Optical Products Division press backgrounder, 1988.

5. Litton Model M-912A/M-915A High Performance Night Vision Goggle, Litton Electron Devices data sheet, (date unknown).

6. Litton Model M-972 High Performance Night Vision Goggle, Litton Electron Devices data sheet, (date unknown).

7. Preliminary Field Test Results: Spring 1989 Evaluation of Night Vision Goggles, Analysis & Technology, Inc. letter report to USCG R&D Center, 5 July 1989.

8. Preliminary Field Test Results: Fall 1989 Evaluations of Night Vision Goggles, Analysis & Technology, Inc. letter report to USCG R&D Center, 8 January 1990.

9. Preliminary Field Test Results: Spring 1990 Evaluation of Night Vision Goggles, Analysis & Technology, Inc., letter report to USCG R&D Center, 15 June 1990.

10. Preliminary Field Test Results: Fall 1990 Evaluation of Night Vision Goggles, Analysis & Technology, Inc., letter report to USCG R&D Center, 11 January 1991.

11. National Search and Rescue Manual, U.S. Coast Guard, COMDTINST M16120.5, 1 August 1986.

12. Edwards, N. C.; Osmer, S. R.; Mazour, T. J.; and Hover, G. L., Factors Affecting Coast Guard SAR Unit Visual Detection Performance, Report No. CG-D-09-82, U.S. Coast Guard Research and Development Center and Analysis & Technology, Inc., August 1981.

13. Koopman, B. O., Search and Screening General Principles with Historical Applications, Pergamon Press, 1980.

14. Cox, D. R., The Analysis of Binary Data, Chapman and Hall, 1977.

15. Steinberg, D., LOGIT: A Supplementary Module for SYSTAT, SYSTAT, Inc., November 1985.

16. Hover, G. L. and Exley, S. A. "Evaluation of SYSTAT Software for Application to POD/SAR Project." A&T Memorandum to LT William Reynolds, 31 October 1989.

DATA APPENDIX

KEY TO DATA APPENDIX

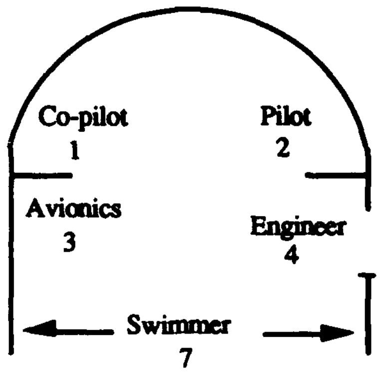
This appendix contains the raw data files for the US Coast Guard Night Vision Goggle experiment conducted in the fall of 1990. Each data file is labeled with the search unit hull number and the date on which the data were collected. The operational Coast Guard units corresponding to each hull number are listed below:

Hull No.	Unit Type	Operational Command
CG-1471	HH-3F	Coast Guard Air Station Cape Cod, MA
CG-41350/337	41-foot UTB	Coast Guard Station New London, CT
CG-41441	41-foot UTB	Coast Guard Station Point Judith, RI
CG-41342	41-foot UTB	Coast Guard Station Montauk, NY

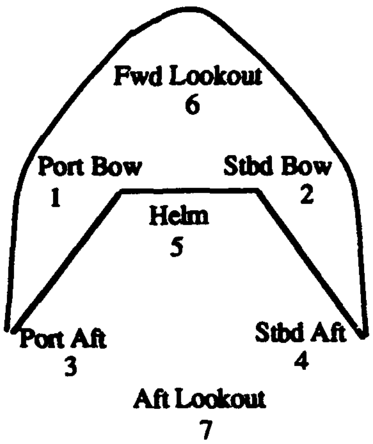
The data files are listed in chronological order by unit. Each file record represents one search unit/target interaction and describes the target detection opportunity using 25 parameters of interest. The following is a key to the format of each record.

Item 1:	DET	Detection? (1 = yes, 0 = no)
Item 2:	LATRNG	Lateral range (nautical miles)
Item 3:	TOT	Time on task (hours)
Item 4:	PRECIP	Precipitation level (0 = none, 1 = light, 2 = moderate, 3 = heavy)
Item 5:	VIS	Visibility (nautical miles)
Item 6:	WDSP	Wind speed (knots)
Item 7:	CLDC	Cloud coverage (tenths of sky obscured)
Item 8:	HS	Significant wave height (feet)
Item 9:	WHCAPS	Whitecap coverage (0 = none, 1 = light, 2 = heavy)
Item 10:	SWDIR	Relative wave direction: (1 = looking into oncoming waves, 0 = looking across the direction of wave travel, -1 = looking at the backside of the waves)
Item 11:	RELHM	Relative humidity (percent)
Item 12:	AIRTP	Air temperature (degrees Celsius)
Item 13:	WTTP	Water temperature (degrees Celsius)
Item 14:	RELAZ	Relative azimuth of artificial light (1 = looking into, 0 = looking across, -1 = looking away from)
Item 15:	LEV	Artificial light level (0 = rural, 1 = suburban, 2 = urban)
Item16:	ELEV	Moon elevation (degrees above(+) or below(-) the horizon)
Item 17:	MOONVIS	Moon visible from search unit (1 = yes, 0 = no)
Item 18:	MOONRA	Moon relative azimuth: (1 = looking into, 0 = looking across, -1 = looking away from)
Item 19:	PHS	Moon phase (0 = none, .2, .5, .7, 1 = full)
Item 20:	SPD	Search speed (knots)
Item 21:	ALTTYPE	Search altitude or NVG type as listed below: • Helicopter data files - search altitude in feet; • UTB data files - NVG type used. (1 = AN/PVS-5, 2 = AN/PVS-7)

Item 22: POS — Position on search unit for detections or -9 for all missed targets. Position codes are shown below.



HELICOPTER



UTB

Item 23:	LO	Lookout identification number for detections or -9 for all missed targets.
Item 24:	EXP	Lookout experience with NVGs (hours) for detections or -9 for all missed targets.
Item 25:	TYNO	Target type (1 = skiff target or 2 = raft target)
Item 26:	SUBTY	Target subtype as listed below:

- Skiff (0 = 18-foot skiff, 1 = 21-foot skiff)
- Raft (0 = raft without retroreflective tape, -1= raft with retroreflective tape)

CG-1471 SEPTEMBER 24 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.7	0.2	0	15	8	0	1.6	0	0	50	15.7	18.7	-1	1	-6	0	0	0.5	90	300	4	51	5	2	-1
1	0.2	0.3	0	15	8	0	1.6	0	0	50	15.7	18.7	0	1	-7	0	0	0.5	90	300	3	50	6	2	-1
1	0.3	0.4	0	15	8	0	1.6	0	1	50	15.7	18.7	0	1	-8	0	0	0.5	90	300	2	56	60	2	-1
1	0	0.5	0	15	8	0	1.6	0	1	50	15.7	18.7	0	1	-9	0	0	0.5	90	300	2	56	60	2	-1
2	0.6	0.2	0	15	8	0	1.6	0	0	50	15.7	18.7	0	1	-6	0	1	0.5	90	300	-9	-9	-9	2	-1
2	0.5	0.3	0	15	8	0	1.6	0	0	50	15.7	18.7	0	1	-7	0	-1	0.5	90	300	-9	-9	-9	2	-1
2	0.4	0.3	0	15	8	0	1.6	0	0	50	15.7	18.7	0	1	-7	0	1	0.5	90	300	-9	-9	-9	2	-1
2	1	0.5	0	15	8	0	1.6	0	0	50	15.7	18.7	0	1	-9	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	0.6	0	15	8	0	1.6	0	0	56	15.7	18.7	0	1	-10	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	0.6	0	15	8	0	1.6	0	0	56	15.7	18.7	0	1	-10	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.8	0.7	0	15	8	0	1.6	0	0	56	15.7	18.7	0	1	-11	0	0	0.5	90	300	-9	-9	-9	2	-1
1	0.1	1.2	0	15	10	0	1.6	0	-1	56	15.8	18.7	0	1	-17	0	0	0.5	90	300	7	51	5	2	-1
1	0.2	1.4	0	15	10	0	1.6	1	-1	53	15.8	18.7	0	1	-19	0	0	0.5	90	300	7	51	5	2	-1
2	0.6	0.8	0	15	10	0	1.6	0	-1	56	15.8	18.7	-1	1	-14	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.3	0.9	0	15	10	0	1.6	0	1	56	15.8	18.7	0	1	-15	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.3	1	0	15	10	0	1.6	0	1	56	15.8	18.7	1	1	-16	0	0	0.5	90	300	-9	-9	-9	2	-1
2	1	1.1	0	15	10	0	1.6	0	-1	56	15.8	18.7	0	1	-16	0	0	0.5	90	300	-9	-9	-9	2	-1
2	1	1.3	0	15	10	0	1.6	0	1	56	15.8	18.7	0	1	-18	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.8	1.5	0	15	10	0	1.6	1	0	53	15.8	18.7	0	1	-20	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.7	1.5	0	15	10	0	1.6	1	0	53	15.9	18.7	0	1	-20	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.6	1.6	0	15	10	0	1.6	1	0	53	15.9	18.7	0	1	-22	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.7	1.6	0	15	10	0	1.6	1	0	53	15.9	18.7	0	1	-22	0	0	0.5	90	300	-9	-9	-9	2	-1
1	0.1	1.8	0	15	14	0	2	1	0	59	16.4	18.6	1	1	-37	0	0	0.5	90	300	1	49	140	2	-1
1	0.1	2	0	15	14	0	2.3	1	0	59	16.4	18.6	1	1	-40	0	0	0.5	90	300	1	49	140	2	-1
2	0.7	1.7	0	15	14	0	2.3	1	0	59	16.4	18.6	-1	1	-37	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	1.8	0	15	14	0	2.3	1	0	59	16.4	18.6	0	1	-38	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	1.8	0	15	14	0	2.3	1	0	59	16.4	18.6	1	1	-38	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.8	2.1	0	15	14	0	2.3	1	0	52	16.4	18.6	0	1	-42	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	2.2	0	15	14	0	2.3	1	0	52	16.5	18.5	0	1	-43	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	2.2	0	15	14	0	2.3	1	0	52	16.5	18.5	0	1	-44	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.7	2.2	0	15	14	0	2.3	1	0	52	16.5	18.5	0	1	-44	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.5	2.4	0	15	14	0	2.3	1	0	52	16.5	18.5	0	1	-45	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.7	2.4	0	15	14	0	2.3	1	0	52	16.5	18.5	0	1	-45	0	0	0.5	90	300	-9	-9	-9	2	-1
1	0.1	2.6	0	15	13	0	2.6	1	0	52	16.4	18.5	-1	1	-49	0	0	0.5	90	300	1	49	140	2	-1
1	0.2	2.9	0	15	13	0	2.6	1	-1	52	16.4	18.5	0	1	-52	0	0	0.5	90	300	3	50	6	2	-1
2	0.9	2.5	0	15	13	0	2.3	1	1	52	16.4	18.5	0	1	-48	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.8	2.6	0	15	13	0	2.6	1	1	52	16.4	18.5	-1	1	-49	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.5	2.7	0	15	13	0	2.6	1	1	52	16.4	18.5	0	1	-49	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	2.7	0	15	13	0	2.6	1	-1	52	16.4	18.5	0	1	-50	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.5	2.7	0	15	13	0	2.6	1	0	52	16.4	18.5	0	1	-50	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.6	2.8	0	15	13	0	2.6	1	-1	52	16.4	18.5	0	1	-50	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.3	2.8	0	15	13	0	2.6	1	-1	52	16.4	18.5	1	1	-51	0	0	0.5	90	300	-9	-9	-9	2	-1
2	1	2.9	0	15	13	0	2.6	1	-1	52	16.4	18.5	0	1	-52	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.5	3	0	15	12	0	2.6	1	1	52	16.4	18.4	0	1	-53	0	0	0.5	90	300	-9	-9	-9	2	-1
2	0.4	3	0	15	12	0	2.6	1	-1	52	16.4	18.4	0	1	-54	0	0	0.5	90	300	-9	-9	-9	2	-1

EOF

CG-41350 SEPTEMBER 24 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.7	1	0	15	9	0	1.6	0	0	50	15.5	16.6	0	1	2	1	1	0.5	15	1	-9	-9	-9	2	-1
2	0.8	1.2	0	15	9	0	1.6	0	0	50	15.5	16.6	-1	1	0	0	1	0.5	15	1	-9	-9	-9	2	-1
2	0.4	1.3	0	15	9	0	1.6	0	-1	50	15.5	16.6	-1	0	-1	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.3	1.3	0	15	8	0	1.6	0	0	50	15.6	16.7	1	1	-2	0	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.5	1.5	0	15	8	0	1.6	0	0	50	15.6	16.7	0	1	-3	0	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.4	1.6	0	15	8	0	1.6	0	0	50	15.6	16.7	0	1	-4	0	1	0.5	15	1	-9	-9	-9	2	-1
2	0.3	1.8	0	15	8	0	1.6	0	-1	50	15.7	16.7	0	1	-6	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.9	1.9	0	15	8	0	1.6	0	0	50	15.7	16.7	0	1	-7	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.7	2	0	15	8	0	1.6	0	0	50	15.7	16.7	0	1	-8	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.4	2.6	0	15	10	0	1.6	0	0	56	15.7	16.7	0	0	-13	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.1	3	0	15	10	0	1.6	0	0	56	15.8	16.7	0	1	-18	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.4	3.6	0	15	10	0	1.6	1	0	53	15.9	16.7	0	0	-24	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.4	3.9	0	15	12	0	2	1	0	53	16	16.7	0	0	-27	0	0	0.5	15	1	-9	-9	-9	2	-1
2	1	4.4	0	15	13	0	2	1	0	59	16.2	16.7	0	1	-33	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.7	4.5	0	15	13	0	2	1	0	59	16.2	16.7	0	1	-35	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.2	4.8	0	15	13	0	2	1	0	59	16.2	16.7	0	1	-38	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.5	5.1	0	15	14	0	2.3	1	0	59	16.4	16.6	0	0	-40	0	0	0.5	15	1	-9	-9	-9	2	-1

EOF

CG-41441 SEPTEMBER 24 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.1	1.7	0	15	8	0	2	0	1	50	15.5	16.6	0	1	-1	0	0	0.5	15	1	4	51	10	2	-1
2	0.5	0.1	0	15	11	0.2	2	0	-1	54	15.3	16.4	0	1	11	1	0	0.5	15	1	-9	-9	-9	2	-1
2	0.8	0.3	0	15	11	0.2	2	0	1	54	15.4	16.4	0	1	10	1	0	0.5	15	1	-9	-9	-9	2	-1
2	0.7	0.4	0	15	10	0.2	2	0	0	54	15.4	16.5	0	1	10	1	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.3	0.5	0	15	10	0.2	2	0	-1	54	15.4	16.5	0	1	9	1	0	0.5	15	1	-9	-9	-9	2	-1
2	0.8	0.6	0	15	10	0	2	0	1	50	15.4	16.5	0	1	8	1	0	0.5	15	1	-9	-9	-9	2	-1
2	0.2	1	0	15	10	0	2	0	-1	50	15.4	16.5	0	1	5	1	0	0.5	15	1	-9	-9	-9	2	-1
2	1	1.4	0	15	9	0	1.6	0	1	50	15.5	16.6	0	1	1	1	0	0.5	15	1	-9	-9	-9	2	-1
2	1	2.2	0	15	8	0	1.6	0	-1	50	15.6	16.7	0	1	-6	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.5	2.5	0	15	8	0	1.6	0	1	50	15.7	16.7	0	1	-9	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.1	5.7	0	15	8	0	1.6	0	0	56	15.7	16.7	0	0	-11	0	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.5	2.9	0	15	10	0	1.6	0	-1	56	15.8	16.7	-1	0	-13	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.4	2.6	0	15	8	0	1.6	0	1	56	15.7	16.7	1	0	-11	0	0	0.5	15	1	-9	-9	-9	2	-1
1	0	4.5	0	15	13	0	2	1	0	59	16.2	16.7	0	1	-32	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.7	3.2	0	15	10	0	1.6	1	0	53	15.8	16.7	-1	0	-19	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0	3.4	0	15	10	0	1.6	1	0	53	15.9	16.7	-1	0	-21	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.3	3.7	0	15	10	0	1.6	1	0	53	15.9	16.7	0	1	-23	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.7	4.8	0	15	13	0	2	1	0	59	16.2	16.7	0	1	-35	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.3	5.2	0	15	14	0	2.3	1	0	59	16.4	16.6	0	1	-39	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.6	3.4	0	15	10	0	1.6	1	0	53	15.9	16.7	-1	0	-21	0	0	0.5	15	1	-9	-9	-9	2	-1

EOF

CG-41342 SEPTEMBER 24 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.9	0.8	0	15	9	0	2	0	0	50	15.5	18.6	0	0	3	1	1	0.5	15	1	-9	-9	-9	2	-1
1	0	1.6	0	15	8	0	1.8	0	0	50	15.6	18.7	0	1	-4	0	-1	0.5	15	1	4	107	0	2	-1
1	0.1	1.7	0	15	8	0	1.8	0	0	50	15.6	18.7	0	1	-6	0	0	0.5	15	1	3	105	0	2	-1
2	0.3	0.1	0	15	10	2	2	0	0	54	15.4	18.5	0	0	9	1	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.8	0.4	0	13	10	0	2	0	0	50	15.4	18.5	0	1	7	1	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.1	0.5	0	15	10	0	2	0	0	50	15.4	18.5	0	1	5	1	1	0.5	15	1	-9	-9	-9	2	-1
2	1	1	0	15	9	0	2	0	0	50	15.5	18.6	0	0	1	0	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.2	1.2	0	15	9	0	2	0	0	50	15.5	18.6	0	1	-1	0	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.6	1.3	0	15	8	0	1.6	0	-1	50	15.6	18.7	0	1	-2	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.8	1.4	0	15	8	0	1.8	0	0	50	15.6	18.7	0	1	-3	0	1	0.5	15	1	-9	-9	-9	2	-1
2	1	1.9	0	15	8	0	1.6	0	0	50	15.7	18.7	-1	1	-7	0	1	0.5	15	1	-9	-9	-9	2	-1
2	0.7	3	0	15	8	0	1.8	0	0	50	15.7	18.7	0	1	-8	0	1	0.5	15	1	-9	-9	-9	2	-1
2	0.8	0.4	0	15	10	0	2	0	1	50	15.4	18.5	0	1	6	1	0	0.5	15	1	-9	-9	-9	2	-1
2	0.7	3.5	0	15	12	0	2	1	0	53	16	18.7	0	1	-27	0	0	0.5	15	1	-9	-9	-9	2	-1
2	1	3.7	0	15	12	0	2	1	0	53	16	18.7	-1	1	-30	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.1	3.8	0	15	13	0	2	1	0	59	16.2	18.7	1	1	-31	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.5	4	0	15	13	0	2	1	0	59	16.2	18.7	0	1	-33	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.5	4.2	0	15	13	0	2	1	0	59	16.2	18.7	0	1	-35	0	0	0.5	15	1	-9	-9	-9	2	-1
2	1	4.3	0	15	14	0	2	1	0	59	16.4	18.6	0	1	-36	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.4	4.5	0	15	14	0	2.3	1	0	59	16.4	18.6	0	1	-39	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.3	3.8	0	15	12	0	2	1	0	59	16	18.7	0	1	-30	0	0	0.5	15	1	-9	-9	-9	2	-1

EOF

CG-41337 SEPTEMBER 26 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.2	0.3	0	15	7	0.6	1.6	0	-1	85	18.7	18.9	1	0	17	0	-1	0.5	15	1	-9	-9	-9	2	-1
2	0.3	0.4	0	15	7	0.6	1.6	0	1	85	18.7	18.9	1	0	17	0	1	0.5	15	1	-9	-9	-9	2	-1
2	0.5	0.8	0	15	7	0.6	1.6	0	0	85	18.7	18.9	1	0	16	0	0	0.5	15	1	-9	-9	-9	2	-1

EOF

CG-41441 SEPTEMBER 26 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1	0.1	0	15	7	0.6	1.6	0	0	85	18.7	18.9	1	0	17	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.4	0.2	0	15	7	0.6	1.6	0	0	85	18.7	18.9	-1	0	17	0	0	0.5	15	1	-9	-9	-9	2	-1
2	0.3	0.7	0	15	8	0.8	1.6	0	0	76	18.7	18.9	-1	0	14	0	0	0.5	15	1	-9	-9	-9	2	-1

EOF

CG-41342 SEPTEMBER 26 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.3	0.1	0	15	7	0.6	1.6	0	-1	85	18.7	18.9	0	1	18	0	-1	0.5	15	0	-9	-9	-9	1	0
2	0.6	0.9	0	15	8	0.8	1.6	0	1	76	18.7	18.9	0	1	14	0	1	0.5	15	0	-9	-9	-9	1	0
2	0.6	1.1	0	15	8	0.8	1.6	0	-1	76	18.7	18.9	0	0	13	0	-1	0.5	15	0	-9	-9	-9	1	0

EOF

CG-41350 SEPTEMBER 28 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.8	0.7	0	10	9	0.5	2	0	-1	95	17.4	18.9	1	1	27	1	-1	0.7	15	1	-9	-9	-9	2	-1
1	0	2.8	0	3	5	1	2	0	0	95	17.8	19	0	1	20	1	1	0.7	15	1	4	108	6	2	-1
1	0.2	3.3	0	3	6	1	1.6	0	-1	90	17.9	19	0	1	17	1	-1	0.7	15	1	4	29	30	1	0
2	0.3	3.6	0	3	7	1	1.6	0	-1	90	17.9	18.9	0	0	14	1	-1	0.7	15	1	-9	-9	-9	1	1
2	0.3	0.4	0	10	10	0.1	2	0	1	95	17.4	19	0	1	27	1	1	0.7	15	1	-9	-9	-9	2	-1
2	0.9	0.5	0	10	10	0.5	2	0	0	95	17.4	19	0	1	27	1	0	0.7	15	1	-9	-9	-9	2	-1
2	0.5	1.1	0	10	9	0.2	2	0	1	95	17.4	18.9	-1	1	27	1	1	0.7	15	1	-9	-9	-9	2	-1
2	0.5	1.3	0	5	8	0.2	2	0	1	95	17.5	19	0	0	26	1	1	0.7	15	1	-9	-9	-9	1	1
2	0.7	1.4	0	5	8	0.2	2	0	-1	95	17.5	19	1	1	26	1	-1	0.7	15	1	-9	-9	-9	2	-1
2	0.9	1.6	0	3	9	0.6	2	0	1	95	17.6	19	0	1	26	1	1	0.7	15	1	-9	-9	-9	2	-1
2	0	2.1	0	4	7	0.6	2	0	0	95	17.6	19.1	0	1	24	1	-1	0.7	15	1	-9	-9	-9	2	-1
2	0.3	2.4	0	3	7	1	2	0	-1	95	17.6	19.1	0	0	22	1	-1	0.7	15	1	-9	-9	-9	1	1
2	0.6	2.7	0	4	5	1	2	0	1	95	17.8	19	-1	1	21	1	1	0.7	15	1	-9	-9	-9	1	1
2	0.6	2.9	0	4	5	1	2	0	1	95	17.8	19	0	1	19	1	1	0.7	15	1	-9	-9	-9	1	0
2	0.9	3.4	0	4	8	1	1.6	0	-1	90	17.9	19	0	1	16	1	-1	0.7	15	1	-9	-9	-9	2	-1
1	0	3.8	0	10	7	6	1.6	0	-1	90	18.2	18.9	0	0	11	1	-1	0.7	15	1	3	108	6	1	1
2	0.7	4	0	10	7	4	2	0	-1	85	18.2	18.9	0	1	9	1	-1	0.7	15	1	5	45	27	2	-1
1	0	4.1	0	10	7	4	2	0	1	85	18.2	18.9	0	1	8	1	1	0.7	15	1	-9	-9	-9	1	0
2	0.9	4.5	0	10	6	4	2	0	1	85	18.2	18.8	0	1	5	1	1	0.7	15	1	-9	-9	-9	1	0
2	1	4.5	0	10	6	4	2	0	-1	85	18.2	18.8	0	1	5	1	-1	0.7	15	1	-9	-9	-9	2	-1
2	0.2	4.6	0	10	8	4	2	0	1	85	18.2	18.7	0	1	4	1	1	0.7	15	1	-9	-9	-9	2	-1
2	0.8	4.8	0	10	6	4	2	0	1	85	18.2	18.7	-1	1	2	1	1	0.7	15	1	-9	-9	-9	1	1

EOF

CG-41441 SEPTEMBER 28 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	1.7	0	10	7	1	2	0	0	95	17.6	19.1	0	1	22	0	0	0.7	19	1	4	103	9	2	-1
1	0	3.4	0	10	7	0.6	1.6	0	0	90	17.9	18.9	-1	0	10	0	0	0.7	19	1	4	118	6	1	1
2	0.8	0.1	0	0.5	10	1	2	0	0	95	17.4	18.9	0	1	27	1	0	0.7	10	1	-9	-9	-9	2	-1
2	0.5	0.6	0	10	8	1	2	0	0	95	17.5	19	0	1	26	1	0	0.7	10	1	-9	-9	-9	1	0
2	0.2	1.1	0	10	8	1	2	0	0	95	17.6	19	0	1	25	1	0	0.7	10	1	-9	-9	-9	2	-1
2	0.4	1.5	0	10	7	1	2	0	0	95	17.6	19.1	0	1	23	1	0	0.7	19	1	-9	-9	-9	2	-1
2	0.9	1.5	0	10	7	1	2	0	0	95	17.6	19.1	0	1	23	0	0	0.7	19	1	-9	-9	-9	2	-1
2	0.4	1.6	0	10	7	1	2	0	0	95	17.6	19.1	0	1	23	0	0	0.7	19	1	-9	-9	-9	1	0
2	0.8	1.7	0	10	7	1	2	0	-1	95	17.6	19.1	0	1	22	0	-1	0.7	19	1	-9	-9	-9	2	-1
2	0.5	1.8	0	10	7	1	2	0	0	95	17.6	19.1	0	1	22	0	0	0.7	19	1	-9	-9	-9	2	-1
2	0.2	2.5	0	10	8	1	2	0	0	95	17.9	19	0	1	18	0	0	0.7	19	1	-9	-9	-9	1	1
2	0.7	2.7	0	10	8	0.6	1.6	0	0	90	17.9	19	0	1	16	0	0	0.7	19	1	-9	-9	-9	2	-1
2	0.6	3	0	10	7	0.6	1.6	0	0	90	17.9	18.9	0	1	14	1	0	0.7	19	1	-9	-9	-9	2	-1
2	0.9	3	0	10	7	0.6	1.6	0	0	90	17.9	18.9	0	1	14	1	0	0.7	19	1	-9	-9	-9	1	1
2	0.6	3.2	0	10	7	0.6	1.6	0	0	90	17.9	18.9	-1	0	13	1	0	0.7	19	1	-9	-9	-9	1	1
2	1	4.1	0	10	6	0.4	2	0	0	85	18.2	18.8	1	0	2	0	0	0.7	18	1	-9	-9	-9	1	1
2	0.7	4.2	0	10	7	0.4	1.6	0	0	85	18.2	18.7	1	1	1	0	0	0.7	18	1	-9	-9	-9	2	-1

EOF

CG-41342 SEPTEMBER 28 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.3	0	10	10	0.1	2	0	-1	95	17.4	19	0	1	27	1	-1	0.7	15	0	3	119	0	1	0
1	0.2	1.2	0	5	8	0.2	2	0	1	95	17.5	19	0	1	27	1	1	0.7	15	0	4	54	24	2	-1
2	0.3	0.1	0	10	10	0.1	2	0	-1	95	17.4	19	0	0	27	1	0	0.7	15	0	-9	-9	-9	1	1
2	0.9	0.3	0	10	10	0.1	2	0	-1	95	17.4	19	0	1	27	1	0	0.7	15	0	-9	-9	-9	2	-1
2	1	0.6	0	10	10	0.5	2	0	1	95	17.4	18.9	0	1	27	1	0	0.7	15	0	-9	-9	-9	1	0
2	0.9	0.6	0	10	9	0.5	2	0	-1	95	17.4	18.9	0	1	27	1	-1	0.7	15	0	-9	-9	-9	2	-1
2	0.4	0.6	0	10	9	0.5	2	0	1	95	17.4	18.9	0	1	27	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.2	1	0	10	9	0.2	2	0	-1	95	17.4	18.9	0	0	27	1	-1	0.7	15	0	-9	-9	-9	1	1
2	0.2	1.8	0	5	8	0.8	2	0	-1	95	17.6	19	1	1	25	1	-1	0.7	15	0	-9	-9	-9	2	-1
2	0.5	2	0	3	8	0.8	2	0	1	95	17.6	19	-1	1	24	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.6	2.3	0	3	7	0.8	2	0	-1	95	17.6	19.1	0	1	23	1	-1	0.7	15	0	-9	-9	-9	2	-1
2	0.6	2.3	0	3	7	1	2	0	0	95	17.6	19.1	0	1	22	1	0	0.7	15	0	-9	-9	-9	2	-1
2	0.5	2.4	0	3	7	1	2	0	1	95	17.6	19.1	0	1	22	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.4	3.2	0	10	6	0.4	1.8	0	1	90	17.9	19	0	1	15	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.5	3.3	0	10	6	0.4	1.8	0	0	90	17.9	19	1	1	15	1	0	0.7	15	0	-9	-9	-9	2	-1
2	0.6	3.3	0	10	7	0.4	1.8	0	-1	90	17.9	18.9	0	1	15	1	-1	0.7	15	0	-9	-9	-9	2	-1
2	0.9	3.6	0	10	7	0.4	1.8	0	1	90	17.9	18.9	-1	1	12	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.8	3.7	0	10	7	0.7	1.8	0	1	90	17.9	18.9	0	0	11	0	1	0.7	15	0	-9	-9	-9	1	1
2	0.5	3.8	0	10	7	0.6	1.8	0	-1	90	18.2	18.9	1	1	11	0	-1	0.7	15	0	-9	-9	-9	2	-1
2	0.9	3.9	0	10	7	0.4	2	0	1	85	18.2	18.9	0	1	9	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.4	4.2	0	10	7	0.4	2	0	-1	85	18.2	18.9	0	1	7	1	-1	0.7	15	0	-9	-9	-9	2	-1
2	0.5	4.3	0	10	7	0.4	2	0	1	85	18.2	18.9	0	1	7	1	1	0.7	15	0	-9	-9	-9	2	-1
2	0.4	4.4	0	10	6	0.4	2	0	1	85	18.2	18.8	0	0	6	1	1	0.7	15	0	-9	-9	-9	1	1

EOF

CG-41337 OCTOBER 01 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.4	0.1	0	15	14	0	2.3	1	0	51	16.7	18.7	1	1	35	1	0	1	18	1	1	55	30	1	1

EOF

CG-41441 OCTOBER 01 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.9	0	15	11	0	2.3	1	0	51	16.6	18.7	1	1	39	1	-1	1	15	1	3	125	0	1	0
1	0.2	1.6	0	15	9	0	2	1	1	53	16.5	18.7	0	1	41	1	0	1	15	1	4	72	15	2	0
1	0.4	4.1	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	1	1	15	1	4	124	75	1	1
2	0.1	0.1	0	15	14	0	2.3	1	-1	51	16.7	18.7	0	1	34	1	1	1	15	1	-9	-9	-9	2	0
2	0.5	0.3	0	15	14	0	2.3	1	-1	51	16.7	18.7	0	1	35	1	1	1	15	1	-9	-9	-9	2	0
2	0.3	0.4	0	15	14	0	2.3	1	-1	51	16.7	18.7	0	1	37	1	1	1	15	1	-9	-9	-9	1	0
2	1	0.7	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	15	1	-9	-9	-9	1	0
2	0.8	1.4	0	15	11	0	2.3	1	-1	53	16.5	18.7	0	1	41	1	1	1	15	1	-9	-9	-9	1	0
2	0.7	2	0	15	9	0	2	1	-1	53	16.5	18.7	0	1	42	1	0	1	15	1	-9	-9	-9	2	0
2	0.5	3.9	0	15	12	0	2	1	0	55	16.9	18.7	1	1	38	1	0	1	15	1	-9	-9	-9	1	1

EOF

CG-41342 OCTOBER 01 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.1	0.6	0	15	14	0	2.3	1	0	51	16.7	18.7	0	1	36	1	0	1	15	0	3	112	6	2	0
2	0	0.4	0	15	14	0	2.3	1	-1	51	16.7	18.7	0	1	35	1	1	1	15	0	-9	-9	-9	1	0
2	0.7	0.4	0	15	14	0	2.3	1	0	51	16.7	18.7	0	1	35	1	0	1	15	0	-9	-9	-9	2	0
2	0.2	0.6	0	15	11	0	2.3	1	0	51	16.6	18.7	0	0	37	1	0	1	15	0	-9	-9	-9	1	1
2	0.9	0.9	0	15	11	0	2.3	1	1	51	16.6	18.7	-1	0	38	1	1	1	15	0	-9	-9	-9	1	1
2	0.8	0.9	0	15	11	0	2.3	1	0	51	16.6	18.7	0	0	38	1	0	1	15	0	-9	-9	-9	1	1
2	0.8	1.1	0	15	11	0	2.3	1	0	51	16.6	18.7	0	1	39	1	0	1	15	0	-9	-9	-9	2	0
2	0.7	1.3	0	15	10	0	2.3	1	-1	51	16.5	18.7	-1	1	40	1	1	1	15	0	-9	-9	-9	2	0
2	0.2	1.5	0	15	10	0	2.3	1	0	53	16.5	18.7	0	1	40	1	0	1	15	0	-9	-9	-9	1	0
2	0.6	2.1	0	15	9	0	2	1	0	53	16.5	18.7	0	1	42	1	0	1	15	0	-9	-9	-9	1	0
2	0.6	2.2	0	15	8	0	2	1	-1	53	16.5	18.7	0	1	42	1	1	1	15	0	-9	-9	-9	2	0
2	0.3	2.6	0	15	8	0	2	1	0	55	16.4	18.7	1	1	42	1	0	1	15	0	-9	-9	-9	1	1
1	0.2	3	0	15	8	0	1.6	1	-1	55	16.5	18.7	0	1	41	1	0	1	18	0	3	44	36	2	0
2	0.4	2.7	0	15	8	0	1.6	1	0	55	16.5	18.7	1	1	42	1	-1	1	18	0	-9	-9	-9	1	1
2	0.7	3.1	0	15	9	0	1.6	1	0	55	16.8	18.7	0	1	41	1	1	1	18	0	-9	-9	-9	1	0
2	0.1	3.8	0	15	12	0	2	1	0	55	16.9	18.7	0	1	38	1	-1	1	18	0	-9	-9	-9	1	0
2	0.5	4	0	15	12	0	2	1	0	55	16.9	18.7	-1	1	38	1	0	1	18	0	-9	-9	-9	2	0
2	1	4	0	15	12	0	2	1	0	55	16.9	18.7	0	1	38	1	1	1	18	0	-9	-9	-9	1	0
2	0.5	4.2	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	1	1	18	0	-9	-9	-9	2	0
2	0.5	4.4	0	15	11	0	2	1	0	55	17	18.7	0	0	36	1	1	1	18	0	-9	-9	-9	1	1
2	0.8	4.5	0	15	11	0	2	1	-1	55	17	18.7	-1	0	35	1	0	1	18	0	-9	-9	-9	1	1
2	0.4	4.5	0	15	11	0	2	1	0	55	17	18.7	0	0	34	1	-1	1	18	0	-9	-9	-9	1	1

EOF

CG-1471 OCTOBER 01 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.3	0.2	0	15	16	0.1	2	1	1	51	17	18.8	1	1	30	1	-1	1	90	300	4	51	9.5	1	1
1	1	0.2	0	15	13	0.1	2	1	0	51	16.7	18.7	-1	1	30	1	0	1	90	300	2	54	20	1	0
1	0	0.3	0	15	13	0.1	2.3	1	1	51	16.7	18.7	0	1	31	1	-1	1	90	300	1	42	45	1	0
1	0.3	0.4	0	15	13	0.1	2.3	1	1	51	16.7	18.7	0	1	32	1	-1	1	90	300	2	54	20	2	0
1	0.4	0.4	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	32	1	0	1	90	300	3	50	10	1	0
1	0.2	0.5	0	15	13	0.1	2.3	1	1	51	16.7	18.7	0	1	32	1	-1	1	90	300	2	54	20	2	0
1	0.2	0.5	0	15	13	0.1	2.3	1	1	51	16.7	18.7	0	1	33	1	-1	1	90	300	2	54	20	1	1
2	0.7	0	0	15	16	0.1	2	1	0	51	17	18.8	-1	1	28	1	0	1	90	300	-9	-9	-9	1	1
2	0.8	0.1	0	15	16	0.1	2	1	0	51	17	18.8	0	1	29	1	0	1	90	300	-9	-9	-9	2	0
2	2.1	0.1	0	15	16	0.1	2	1	0	51	17	18.8	0	1	29	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	0.2	0	15	13	0.1	2	1	0	51	16.7	18.7	1	1	30	1	0	1	90	300	-9	-9	-9	1	1
2	0.2	0.2	0	15	13	0.1	2	1	0	51	16.7	18.7	0	1	31	1	0	1	90	300	-9	-9	-9	2	0
2	1.5	0.3	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	31	1	0	1	90	300	-9	-9	-9	2	0
2	1.2	0.3	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	31	1	0	1	90	300	-9	-9	-9	2	0
2	2.2	0.3	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	31	1	0	1	90	300	-9	-9	-9	1	0
2	1.7	0.3	0	15	13	0.1	2.3	1	0	51	16.7	18.7	-1	1	31	1	0	1	90	300	-9	-9	-9	1	1
2	0.9	0.4	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	31	1	0	1	90	300	-9	-9	-9	1	1
2	0.9	0.4	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	32	1	0	1	90	300	-9	-9	-9	2	0
2	1.1	0.4	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	1.3	0.4	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	0.4	0.4	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	32	1	0	1	90	300	-9	-9	-9	2	0
2	2	0.5	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	1	0.5	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	33	1	0	1	90	300	-9	-9	-9	1	1
2	1	0.6	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	33	1	0	1	90	300	-9	-9	-9	2	0
2	0.7	0.6	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	33	1	0	1	90	300	-9	-9	-9	1	0
2	1.5	0.6	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	33	1	0	1	90	300	-9	-9	-9	2	0
2	1.7	0.6	0	15	13	0.1	2.3	1	0	51	16.7	18.7	0	1	33	1	0	1	90	300	-9	-9	-9	1	0
2	2.2	0.7	0	15	14	0.1	2.3	1	0	51	16.7	18.7	0	1	34	1	0	1	90	300	-9	-9	-9	1	1
1	0.6	0.8	0	15	14	0	2.3	1	0	51	16.7	18.7	1	1	35	1	0	1	90	300	4	52	4.5	1	1
1	0.6	0.9	0	15	14	0	2.3	1	0	51	16.7	18.7	0	1	36	1	0	1	90	300	2	54	20	1	1
1	1.5	1.1	0	15	14	0	2.3	1	0	51	16.7	18.7	0	1	37	1	0	1	90	300	4	52	4.5	1	0
1	0.3	1.2	0	15	11	0	2.3	1	1	51	16.6	18.7	0	1	38	1	0	1	90	300	2	54	20	2	0
1	1.4	1.4	0	15	11	0	2.3	1	1	51	16.6	18.7	0	1	38	1	0	1	90	300	2	54	20	1	0
1	0.1	1.4	0	15	11	0	2.3	1	0	51	16.6	18.7	0	1	39	1	0	1	90	300	1	42	45	1	0
2	0.4	0.7	0	15	14	0	2.3	1	-1	51	16.7	18.7	-1	1	35	1	1	1	90	300	-9	-9	-9	1	1
2	1.6	0.9	0	15	14	0	2.3	1	1	51	16.7	18.7	0	1	36	1	-1	1	90	300	-9	-9	-9	1	1
2	1.5	1	0	15	14	0	2.3	1	1	51	16.7	18.7	0	1	36	1	-1	1	90	300	-9	-9	-9	1	1
2	0.8	1.1	0	15	14	0	2.3	1	-1	51	16.7	18.7	0	1	37	1	1	1	90	300	-9	-9	-9	2	0
2	0.6	1.2	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	90	300	-9	-9	-6	1	0
2	1.9	1.2	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	0.9	1.3	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	1.2	1.3	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	90	300	-9	-9	-9	2	0
2	0.4	1.3	0	15	11	0	2.3	1	1	51	16.6	18.7	0	1	38	1	-1	1	90	300	-9	-9	-9	1	0
2	1.1	1.3	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	90	300	-9	-9	-9	2	0
2	0.2	1.3	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	38	1	1	1	90	300	-9	-9	-9	2	0
2	0.2	1.4	0	15	11	0	2.3	1	-1	51	16.6	18.7	0	1	39	1	1	1	90	300	-9	-9	-9	2	0
1	0.5	1.6	0	15	11	0	2.3	1	-1	53	16.5	18.7	0	1	40	1	0	1	90	300	2	54	20	2	0
1	1	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	1	1	41	1	-1	1	90	300	7	51	10	1	0
1	0.3	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	2	54	20	1	0
1	0	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	7	51	10	2	0
1	0.1	1.8	0	15	11	0	2.3	1	1	53	16.5	18.7	0	1	41	1	0	1	90	300	2	54	20	2	0
1	0.3	1.8	0	15	11	0	2.3	1	1	53	16.5	18.7	0	1	41	1	-1	1	90	300	2	54	20	1	1
1	0.9	1.9	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	7	51	10	1	0
2	0.9	1.5	0	15	11	0	2.3	1	0	53	16.6	18.7	0	1	40	1	0	1	90	300	-9	-9	-9	2	0
2	2	1.5	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	40	1	0	1	90	300	-9	-9	-9	1	0
2	0.9	1.6	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	40	1	0	1	90	300	-9	-9	-9	1	0
2	0.1	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	40	1	0	1	90	300	-9	-9	-9	1	0
2	1.7	1.7	0	15	11	0	2.3	1	0	53	16.5	18.7	-1	1	40	1	0	1	90	300	-9	-9	-9	1	1

CG-1471 OCTOBER 01 1990 (Continued)

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.7	1.7	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	40	1	0	1	90	300	-9	-9	-9	1	1
2	0.9	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	-9	-9	-9	2	0
2	1.2	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	-9	-9	-9	1	0
2	2.1	1.8	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	-9	-9	-9	1	0
2	1.5	1.9	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	-9	-9	-9	1	1
2	1.1	1.9	0	15	11	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	-9	-9	-9	2	0
2	2.2	2	0	15	9	0	2.3	1	0	53	16.5	18.7	0	1	41	1	0	1	90	300	-9	-9	-9	1	1
1	0.4	2	0	15	9	0	1.6	1	0	55	16.5	18.7	0	1	41	1	-1	1	100	300	2	54	20	1	1
1	0.4	2	0	15	9	0	1.6	1	0	55	16.8	18.7	1	1	41	1	-1	1	100	300	2	54	20	1	1
1	0.5	2.1	0	15	9	0	1.6	1	0	55	16.8	18.7	0	1	41	1	0	1	100	300	2	54	20	1	1
1	0.5	2.3	0	15	9	0	1.6	1	0	55	16.8	18.7	0	1	40	1	0	1	100	300	4	52	4	2	0
1	0.5	2.4	0	15	9	0	1.6	1	0	55	16.8	18.7	0	1	40	1	0	1	100	300	7	51	9	1	0
1	0.3	2.4	0	15	9	0	1.6	1	1	55	16.8	18.7	0	1	40	1	0	1	100	300	4	52	4	2	0
1	0.7	2.4	0	15	9	0	1.6	1	0	55	16.8	18.7	0	1	40	1	0	1	100	300	1	42	45	1	0
1	0.9	2.5	0	15	9	0	1.6	1	-1	55	16.8	18.7	0	1	40	1	0	1	100	300	4	52	4	2	0
1	0.5	2.5	0	15	9	0	1.6	1	0	55	16.8	18.7	1	1	40	1	-1	1	100	300	1	42	45	1	0
1	1	2.5	0	15	9	0	1.6	1	-1	55	16.8	18.7	0	1	40	1	0	1	100	300	2	54	20	2	0
1	0.1	2.5	0	15	12	0	1.6	1	0	55	16.9	18.7	0	1	40	1	1	1	100	300	3	50	10	2	0
1	1.3	2.5	0	15	12	0	1.6	1	1	55	16.9	18.7	0	1	40	1	0	1	100	300	2	54	20	1	0
1	0.3	2.5	0	15	12	0	1.6	1	-1	55	16.9	18.7	0	1	40	1	0	1	100	300	3	50	10	2	0
1	0	2.6	0	15	12	0	1.6	1	0	55	16.9	18.7	0	1	39	1	1	1	100	300	7	51	9	1	0
2	0.6	2	0	15	9	0	1.6	1	1	55	16.9	18.7	0	1	41	1	0	1	100	300	-9	-9	-9	1	1
2	1.7	2.1	0	15	9	0	1.6	1	1	55	16.9	18.7	0	1	41	1	0	1	100	300	-9	-9	-9	1	1
2	1.4	2.2	0	15	9	0	1.6	1	1	55	16.9	18.7	0	1	41	1	0	1	100	300	-9	-9	-9	1	1
2	1.5	2.3	0	15	9	0	1.6	1	-1	55	16.9	18.7	0	1	40	1	0	1	100	300	-9	-9	-9	1	0
2	2	2.4	0	15	9	0	1.6	1	-1	55	16.9	18.7	0	1	40	1	0	1	100	300	-9	-9	-9	2	0
1	0.3	2.7	0	15	12	0	2	1	1	55	16.9	18.7	0	1	39	1	0	1	90	300	2	54	20	1	1
1	1	2.7	0	15	12	0	2	1	0	55	16.9	18.7	1	1	39	1	-1	1	90	300	3	50	10	1	1
1	0.1	2.8	0	15	12	0	2	1	-1	55	16.9	18.7	0	1	38	1	0	1	90	300	1	42	45	2	0
1	0	2.8	0	15	12	0	2	1	1	55	16.9	18.7	0	1	38	1	0	1	90	300	2	54	20	1	0
1	1.1	2.9	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	-1	1	90	300	3	50	10	1	0
1	0.3	3	0	15	11	0	2	1	1	55	17	18.7	0	1	37	1	0	1	90	300	1	42	45	2	0
1	0.2	3	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	0	1	90	300	2	54	20	2	0
1	0.8	3.1	0	15	11	0	2	1	-1	55	17	18.7	1	1	36	1	0	1	90	300	1	42	45	1	0
2	1.1	2.7	0	15	12	0	2	1	0	55	16.9	18.7	0	1	39	1	1	1	90	300	-9	-9	-9	2	0
2	2.1	2.7	0	15	12	0	2	1	0	55	16.9	18.7	0	1	39	1	1	1	90	300	-9	-9	-9	1	0
2	0.9	2.8	0	15	12	0	2	1	0	55	16.9	18.7	0	1	38	1	1	1	90	300	-9	-9	-9	1	0
2	1	2.8	0	15	12	0	2	1	0	55	16.9	18.7	0	1	38	1	-1	1	90	300	-9	-9	-9	2	0
2	1.8	2.9	0	15	12	0	2	1	0	55	16.9	18.7	-1	1	38	1	1	1	90	300	-9	-9	-9	1	1
2	2.2	2.9	0	15	12	0	2	1	0	55	16.9	18.7	1	1	38	1	-1	1	90	300	-9	-9	-9	1	1
2	1.1	2.9	0	15	12	0	2	1	0	55	16.9	18.7	-1	1	38	1	1	1	90	300	-9	-9	-9	1	1
2	0.8	2.9	0	15	12	0	2	1	0	55	16.9	18.7	0	1	37	1	1	1	90	300	-9	-9	-9	2	0
2	1.2	3	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	1	1	90	300	-9	-9	-9	1	0
2	0.4	3	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	1	1	90	300	-9	-9	-9	2	0
1	0.5	3	0	15	11	0	2	1	-1	55	17	18.7	0	1	37	1	0	1	90	300	7	51	9	1	0
2	2	3	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	-1	1	90	300	-9	-9	-9	1	0
2	0.3	3	0	15	11	0	2	1	0	55	17	18.7	0	1	37	1	-1	1	90	300	-9	-9	-9	1	1
2	1.3	3.1	0	15	11	0	2	1	0	55	17	18.7	0	1	36	1	-1	1	90	300	-9	-9	-9	2	0
2	1.6	3.1	0	15	11	0	2	1	0	55	17	18.7	0	1	36	1	-1	1	90	300	-9	-9	-9	1	0
2	2.2	3.2	0	15	11	0	2	1	0	55	17	18.7	0	1	36	1	-1	1	90	300	-9	-9	-9	1	1
1	0.6	3.2	0	15	11	0	2	1	-1	55	17	18.7	0	1	36	1	0	1	90	300	2	54	20	1	1
1	0.3	3.3	0	15	11	0	2	1	-1	55	17	18.7	0	1	36	1	-1	1	90	300	2	54	20	1	1
1	0.7	3.3	0	15	11	0	2	1	0	55	17	18.7	0	1	35	1	0	1	90	300	4	52	4	1	1
1	0.5	3.3	0	15	11	0	2	1	1	55	17	18.7	0	1	35	1	0	1	90	300	2	54	20	1	1
1	0.5	3.5	0	15	13	0	2	1	-1	55	16.9	18.6	0	1	34	1	0	1	90	300	4	52	4	2	0
1	0.4	3.6	0	15	13	0	2.3	1	0	55	16.9	18.6	1	1	33	1	0	1	90	300	7	51	9	2	0
1	0.8	3.7	0	15	13	0	2.3	1	-1	55	16.9	18.6	0	1	33	1	-1	1	90	300	2	54	20	1	0
2	1.5	3.4	0	15	11	0	2	1	0	55	17	18.7	0	1	35	1	0	1	90	300	-9	-9	-9	1	1
2	1.5	3.4	0	15	11	0	2	1	0	55	17	18.7	0	1	35	1	0	1	90	300	-9	-9	-9	1	1

CG-1471 OCTOBER 01 1990 (Continued)

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1.5	3.5	0	15	13	0	2.3	1	0	55	16.9	18.6	0	1	34	1	0	1	90	300	-9	-9	-9	1	0
2	0.5	3.6	0	15	13	0	2.3	1	0	55	16.9	18.6	0	1	33	1	0	1	90	300	-9	-9	-9	1	0
2	1.9	3.6	0	15	13	0	2.3	1	0	55	16.9	18.6	0	1	33	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	3.7	0	15	13	0	2.3	1	0	55	16.9	18.6	0	1	33	1	0	1	90	300	-9	-9	-9	2	0
2	0.3	3.7	0	15	13	0	2.3	1	0	55	16.9	18.6	0	1	32	1	0	1	90	300	-9	-9	-9	1	0
2	1.2	3.7	0	15	13	0	2.3	0	0	55	16.9	18.6	0	1	32	1	0	1	90	300	-9	-9	-9	2	0

EOF

CG-41337 OCTOBER 03 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.1	0.2	0	15	15	0	2.3	1	0	64	17.5	17.9	-1	1	28	1	1	1	15	1	3	130	0	1	1
1	0.1	0.4	0	15	15	0	2.3	1	1	64	17.3	17.8	0	1	31	1	0	1	15	1	4	58	20	2	0
2	1	0.1	0	15	15	0	2.3	1	0	64	17.5	17.9	-1	1	28	1	0	1	15	1	-9	-9	-9	2	0
2	1	0.6	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	33	1	0	1	15	1	-9	-9	-9	2	0
2	0.8	0.8	0	15	14	0	2.3	1	0	64	17.3	17.8	0	1	34	1	0	1	15	1	-9	-9	-9	1	1
2	0.3	0.8	0	15	14	0	2.3	1	0	64	17.3	17.8	-1	1	35	1	0	1	15	1	-9	-9	-9	2	0
2	0.5	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	1	1	37	1	0	1	15	1	-9	-9	-9	2	0
2	0	1.6	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	43	1	-1	1	15	1	-9	-9	-9	1	0

EOF

CG-41441 OCTOBER 03 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.2	0.4	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	33	1	1	1	9	1	3	60	20	2	0
1	0	0.9	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	38	1	0	1	12	1	4	127	4	2	0
1	0.1	1.7	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	45	1	-1	1	15	1	3	126	0	1	0
2	1	0.6	0	15	14	0	2.3	1	0	64	17.3	17.8	0	1	34	1	1	1	15	1	-9	-9	-9	2	0
2	0.9	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	35	1	-1	1	15	1	-9	-9	-9	1	0
2	0.4	1.3	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	1	1	8	1	-9	-9	-9	1	0
2	0.9	1.5	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	43	1	-1	1	8	1	-9	-9	-9	1	0

EOF

CG-1471 OCTOBER 03 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	0.1	0.1	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	31	1	-1	1	100	300	1	53	25	2	0
1	0.1	0.1	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	31	1	-1	1	100	300	2	42	50	1	1
1	2	0.2	0	15	15	0	2.3	1	0	64	17.3	17.8	-1	1	32	1	0	1	100	300	4	51	14	1	0
1	1.1	0.2	0	15	15	0	2.3	1	1	64	17.3	17.8	0	1	32	1	0	1	100	300	1	53	25	1	0
1	0.1	0.4	0	15	15	0	2.3	1	-1	64	17.3	17.6	0	1	33	1	1	1	100	300	3	50	15	1	0
1	0.3	0.4	0	15	15	0	2.3	1	1	64	17.3	17.8	0	1	34	1	-1	1	100	300	1	53	25	1	0
1	0.7	0.5	0	15	14	0	2.3	1	0	64	17.3	17.8	1	1	35	1	0	1	100	300	1	53	25	1	0
1	1.7	0.5	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	35	1	0	1	100	300	4	51	14	1	0
2	1.4	0	0	15	15	0	2.3	1	0	64	17.3	17.8	-1	1	30	1	0	1	100	300	-9	-9	-9	1	1
2	0.6	0.2	0	15	15	0	2.3	1	0	64	17.3	17.8	1	1	31	1	0	1	100	300	-9	-9	-9	1	1
2	1.9	0.3	0	15	15	0	2.3	1	0	64	17.3	17.8	1	1	32	1	0	1	100	300	-9	-9	-9	1	1
2	2.7	0.3	0	15	15	0	2.3	1	0	64	17.3	17.8	1	1	33	1	0	1	100	300	-9	-9	-9	1	1
2	3.7	0.4	0	15	15	0	2.3	1	0	64	17.3	17.8	1	1	34	1	0	1	100	300	-9	-9	-9	1	1
2	1.2	0.1	0	15	15	0	2.3	1	0	64	17.3	17.8	-1	1	31	1	0	1	100	300	-9	-9	-9	2	0
2	0.6	0.2	0	15	15	0	2.3	1	0	64	17.3	17.8	-1	1	31	1	0	1	100	300	-9	-9	-9	2	0
2	0.9	0.3	0	15	15	0	2.3	1	0	64	17.3	17.8	1	1	33	1	0	1	100	300	-9	-9	-9	2	0
2	1.6	0.3	0	15	15	0	2.3	1	0	64	17.3	17.8	1	1	33	1	0	1	100	300	-9	-9	-9	2	0
2	3.4	0.2	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	32	1	0	1	100	300	-9	-9	-9	1	0
2	2.3	0.3	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	33	1	0	1	100	300	-9	-9	-9	1	0
2	1.4	0.4	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	33	1	0	1	100	300	-9	-9	-9	1	0
2	1.3	0.4	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	34	1	0	1	100	300	-9	-9	-9	2	0
2	0.7	0.4	0	15	15	0	2.3	1	0	64	17.3	17.8	0	1	34	1	0	1	100	300	-9	-9	-9	2	0
2	0.7	0.5	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	35	1	0	1	100	300	-9	-9	-9	2	0
2	1.4	0.5	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	35	1	0	1	100	300	-9	-9	-9	2	0
2	4	0.1	0	15	15	0	2.3	1	0	69	17.3	17.8	0	1	30	1	0	1	100	300	-9	-9	-9	1	0
2	2.9	0.1	0	15	15	0	2.3	1	0	69	17.3	17.8	0	1	31	1	0	1	100	300	-9	-9	-9	1	0
2	2.2	0.5	0	15	14	0	2.3	1	0	69	17.3	17.8	0	1	35	1	0	1	100	300	-9	-9	-9	1	0
2	3.1	0.6	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	35	1	0	1	100	300	-9	-9	-9	1	0
2	1.1	0.1	0	15	15	0	2.3	1	0	69	17.3	17.8	0	1	30	1	0	1	100	300	-9	-9	-9	2	0
2	0.9	0.1	0	15	15	0	2.3	1	0	69	17.3	17.8	0	1	31	1	0	1	100	300	-9	-9	-9	2	0
2	1.7	0.2	0	15	15	0	2.3	1	0	69	17.3	17.8	0	1	32	1	0	1	100	300	-9	-9	-9	2	0
2	2.3	0.2	0	15	15	0	2.3	1	0	69	17.3	17.8	0	1	31	1	1	1	100	300	-9	-9	-9	1	1
2	3.9	0.5	0	15	14	0	2.3	1	0	64	17.3	17.8	0	1	34	1	1	1	100	300	-9	-9	-9	1	0
1	0.7	0.8	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	40	1	0	1	100	300	4	51	14	1	1
1	0.3	0.8	0	15	14	0	2.6	1	0	69	17.3	17.8	1	1	40	1	0	1	100	300	1	53	25	1	0
1	1.9	1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	-1	1	100	300	1	53	25	1	1
1	0.1	1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	0	1	100	300	2	42	50	1	0
1	1.1	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	1	1	42	1	0	1	100	300	1	53	25	1	0
1	0.4	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	42	1	0	1	100	300	1	53	25	2	0
1	0.1	1.2	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	43	1	0	1	100	300	1	53	25	2	0
2	2.2	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	38	1	1	1	100	300	-9	-9	-9	1	1
2	1.2	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	38	1	1	1	100	300	-9	-9	-9	1	1
2	0.2	0.8	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	39	1	1	1	100	300	-9	-9	-9	1	1
2	2.8	1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	-1	1	100	300	-9	-9	-9	1	1
2	3.7	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	42	1	-1	1	100	300	-9	-9	-9	1	1
2	1.3	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	38	1	1	1	100	300	-9	-9	-9	2	0
2	0.3	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	39	1	1	1	100	300	-9	-9	-9	2	0
2	0.7	0.8	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	39	1	-1	1	100	300	-9	-9	-9	2	0
2	1.6	0.9	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	40	1	-1	1	100	300	-9	-9	-9	2	0
2	3.4	0.6	0	15	14	0	2.6	1	0	69	17.3	17.8	-1	1	37	1	1	1	100	300	-9	-9	-9	1	0
2	2.7	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	-1	1	38	1	1	1	100	300	-9	-9	-9	1	0
2	1.6	0.8	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	39	1	1	1	100	300	-9	-9	-9	1	0
2	0.7	0.9	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	40	1	1	1	100	300	-9	-9	-9	1	0
2	1.2	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	42	1	-1	1	100	300	-9	-9	-9	1	0
2	2.3	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	42	1	-1	1	100	300	-9	-9	-9	1	0
2	3.1	1.2	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	43	1	-1	1	100	300	-9	-9	-9	1	0
2	1.8	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	1	1	100	300	-9	-9	-9	2	0
2	0.8	1.1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	42	1	1	1	100	300	-9	-9	-9	2	0
2	3.8	0.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	38	1	1	1	100	300	-9	-9	-9	1	0
2	2.9	0.8	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	39	1	1	1	100	300	-9	-9	-9	1	0
2	1.8	0.9	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	40	1	1	1	100	300	-9	-9	-9	1	0
2	0.7	1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	40	1	1	1	100	300	-9	-9	-9	1	0
2	2	1.2	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	43	1	-1	1	100	300	-9	-9	-9	1	0

CG-1471 OCTOBER 03 1990 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1.4	1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	1	1	100	300	-9	-9	-9	2	0
2	0.5	1	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	41	1	1	1	100	300	-9	-9	-9	2	0
2	1.4	1.2	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	43	1	-1	1	100	300	-9	-9	-9	2	0
2	1.6	0.8	0	15	14	0	2.6	1	1	69	17.3	17.8	-1	1	38	1	0	1	100	300	-9	-9	-9	1	1
2	1.8	0.9	0	15	14	0	2.6	1	-1	69	17.3	17.8	0	1	40	1	0	1	100	300	-9	-9	-9	1	0
1	0.2	1.3	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	45	1	-1	1	100	300	1	53	25	2	0
1	0.3	1.3	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	45	1	-1	1	100	300	1	53	25	1	1
1	1	1.5	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	46	1	0	1	100	300	1	53	25	1	0
1	2.4	1.5	0	15	14	0	2.6	1	0	69	17.3	17.8	-1	1	47	1	0	1	100	300	1	53	25	1	0
1	1.7	1.5	0	15	14	0	2.6	1	0	69	17.3	17.8	1	1	47	1	0	1	100	300	4	51	14	1	1
1	0	1.6	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	47	1	-1	1	100	300	3	50	15	1	0
1	0.4	1.6	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	47	1	0	1	100	300	2	42	50	2	0
1	0.3	1.7	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	48	1	-1	1	100	300	1	53	25	1	0
1	0.7	1.8	0	15	13	0	2.6	1	-1	69	17.3	17.8	0	1	49	1	0	1	100	300	1	53	25	2	0
2	1.2	1.3	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	45	1	0	1	100	300	-9	-9	-9	1	1
2	0.6	1.4	0	15	14	0	2.6	1	-1	69	17.3	17.8	0	1	46	1	0	1	100	300	-9	-9	-9	1	1
2	2.6	1.6	0	15	14	0	2.6	1	-1	69	17.3	17.8	0	1	47	1	0	1	100	300	-9	-9	-9	1	1
2	3.7	1.7	0	15	14	0	2.6	1	-1	69	17.3	17.8	0	1	48	1	0	1	100	300	-9	-9	-9	1	1
2	1.4	1.4	0	15	14	0	2.6	1	1	69	17.3	17.8	-1	1	45	1	0	1	100	300	-9	-9	-9	2	0
2	0.4	1.4	0	15	14	0	2.6	1	1	69	17.3	17.8	-1	1	46	1	0	1	100	300	-9	-9	-9	2	0
2	0.6	1.5	0	15	14	0	2.6	1	-1	69	17.3	17.8	1	1	46	1	0	1	100	300	-9	-9	-9	2	0
2	1.6	1.6	0	15	14	0	2.6	1	-1	69	17.3	17.8	1	1	47	1	0	1	100	300	-9	-9	-9	2	0
2	3.4	1.4	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	46	1	0	1	100	300	-9	-9	-9	1	0
2	1.4	1.6	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	47	1	0	1	100	300	-9	-9	-9	1	0
2	0.7	1.8	0	15	13	0	2.6	1	-1	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	1	0
2	1.6	1.8	0	15	13	0	2.6	1	-1	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	1	0
2	1.4	1.6	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	47	1	0	1	100	300	-9	-9	-9	2	0
2	1.6	1.8	0	15	13	0	2.6	1	-1	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	2	0
2	3.8	1.3	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	45	1	0	1	100	300	-9	-9	-9	1	0
2	3	1.3	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	45	1	0	1	100	300	-9	-9	-9	1	0
2	1.9	1.4	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	46	1	0	1	100	300	-9	-9	-9	1	0
1	1.1	1.6	0	15	14	0	2.6	1	0	69	17.3	17.8	1	1	48	1	-1	1	100	300	2	42	50	1	0
2	2.2	1.8	0	15	13	0	2.6	1	-1	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	1	0
2	3	1.8	0	15	13	0	2.6	1	-1	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	1	0
2	1	1.3	0	15	14	0	2.6	1	1	69	17.3	17.8	0	1	45	1	0	1	100	300	-9	-9	-9	2	0
2	0.9	1.4	0	15	14	0	2.6	1	-1	69	17.3	17.8	0	1	46	1	0	1	100	300	-9	-9	-9	2	0
2	1.9	1.5	0	15	14	0	2.6	1	-1	69	17.3	17.8	0	1	46	1	0	1	100	300	-9	-9	-9	2	0
2	2.8	1.4	0	15	14	0	2.6	1	0	69	17.3	17.8	0	1	46	1	1	1	100	300	-9	-9	-9	1	1
1	2.7	2	0	15	13	0	2.6	1	0	69	17.3	17.8	-1	1	50	1	1	1	100	300	3	50	15	1	0
1	0.5	2.1	0	15	13	0	2.6	1	1	69	17.3	17.8	0	1	51	1	0	1	100	300	1	53	25	1	1
1	0.3	2.2	0	15	12	0	2.6	1	0	69	17.4	17.8	1	1	51	1	-1	1	100	300	1	53	25	1	0
1	0.1	2.3	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	1	53	25	1	0
1	1.3	2.3	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	4	51	14	1	0
1	1.2	2.4	0	15	12	0	2.3	1	0	69	17.4	17.8	1	1	52	1	-1	1	100	300	1	53	25	1	0
1	0.5	2.4	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	-1	1	100	300	1	53	25	2	0
1	1.5	2.4	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	4	51	14	2	0
2	2.2	1.9	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	1	1
2	1.3	2	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	50	1	0	1	100	300	-9	-9	-9	1	1
2	0.2	2.1	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	1	1
2	1.7	2.2	0	15	12	0	2.6	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	1	1
2	2.7	2.3	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	1	1
2	3.7	2.4	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	1	1
2	1.2	1.9	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	50	1	0	1	100	300	-9	-9	-9	2	0
2	0.4	2	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	50	1	0	1	100	300	-9	-9	-9	2	0
2	0.7	2.1	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	2	0
2	1.5	2.1	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	2	0
2	3.6	1.9	0	15	13	0	2.6	1	0	69	17.3	17.8	-1	1	49	1	0	1	100	300	-9	-9	-9	1	0
2	1.7	2	0	15	13	0	2.6	1	0	69	17.3	17.8	-1	1	51	1	0	1	100	300	-9	-9	-9	1	0
2	0.7	2.2	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	1	0
2	2.3	2.4	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	1	0
2	3.2	2.5	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	53	1	0	1	100	300	-9	-9	-9	1	0
2	1.8	2.3	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	2	0
2	0.7	2.4	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	2	0

CG-1471 OCTOBER 03 1990 (Continued)

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	3.9	2	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	50	1	0	1	100	300	-9	-9	-9	1	0
2	2.9	2.1	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	49	1	0	1	100	300	-9	-9	-9	1	0
2	2	2.2	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	1	0
2	0.9	2.2	0	15	12	0	2.6	1	0	69	17.4	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	1	0
2	2.1	2.5	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	53	1	0	1	100	300	-9	-9	-9	1	0
2	1.6	2.2	0	15	12	0	2.6	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	2	0
2	0.6	2.3	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	52	1	0	1	100	300	-9	-9	-9	2	0
2	1.8	2.1	0	15	13	0	2.6	1	0	69	17.3	17.8	0	1	51	1	0	1	100	300	-9	-9	-9	1	1
1	0.2	2.6	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	2	53	25	2	0
1	0.4	2.6	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	2	53	25	1	1
1	0.8	2.7	0	15	13	0	2.3	1	-1	69	17.4	17.8	0	1	54	1	0	1	100	300	2	53	25	2	0
1	0.1	2.8	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	3	50	15	1	0
1	0.8	2.9	0	15	13	0	2.3	1	0	69	17.4	17.8	1	1	54	1	-1	1	100	300	4	51	14	1	0
1	0.7	3	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	55	1	0	1	100	300	2	53	25	1	0
1	0.5	3	0	15	13	0	2.3	1	-1	69	17.4	17.8	0	1	55	1	0	1	100	300	2	53	25	2	0
2	1.1	2.5	0	15	12	0	2.3	1	0	69	17.4	17.8	-1	1	53	1	0	1	100	300	-9	-9	-9	1	1
2	0.7	2.7	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	1
2	1.5	2.8	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	1
2	2.8	2.8	0	15	13	0	2.3	1	-1	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	1
2	3.7	2.9	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	1
2	2.2	2.5	0	15	12	0	2.3	1	0	69	17.4	17.8	-1	1	53	1	0	1	100	300	-9	-9	-9	2	0
2	1.5	2.8	0	15	13	0	2.3	1	0	69	17.4	17.8	-1	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	0.5	2.7	0	15	13	0	2.3	1	0	69	17.4	17.8	-1	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	0.5	2.8	0	15	13	0	2.3	1	0	69	17.4	17.8	1	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	1.6	2.8	0	15	13	0	2.3	1	-1	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	2.3	2.6	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	1
2	3.4	2.7	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	2.6	2.8	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	1.1	2.8	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	0.4	2.9	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	1.4	2.9	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	0.9	2.9	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	3.9	2.8	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	3.1	2.8	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	2	2.7	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	1.3	2.7	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0
2	2.2	3	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	55	1	0	1	100	300	-9	-9	-9	1	0
2	1	2.8	0	15	12	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	1.4	2.7	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	2	0
2	3.8	2.9	0	15	13	0	2.3	1	0	69	17.4	17.8	0	1	54	1	0	1	100	300	-9	-9	-9	1	0

EOF

CG-1471 OCTOBER 05 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	IS	WHCAPS	SWDIR	RELHM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
1	1.4	0	0	15	14	0.7	4.3	0	1	82	19	17.6	0	1	32	1	0	1	90	300	4	51	17	1	1
1	0.9	0.1	0	15	14	0.7	4.3	0	0	82	19	17.6	0	1	32	1	-1	1	90	300	1	42	53	1	1
1	0.1	0.2	0	15	14	0.7	4.3	0	0	82	19	17.6	0	1	33	1	1	1	90	300	1	42	53	1	1
1	1.2	0.3	0	15	16	0.7	4.3	0	0	82	18.9	17.4	0	1	34	1	-1	1	90	300	4	51	17	1	0
1	0.6	0.3	0	15	16	0.7	4.3	0	0	82	18.9	17.4	0	1	34	1	-1	1	90	300	1	42	53	1	0
1	0.4	0.4	0	15	16	0.7	3.6	0	0	82	18.9	17.4	0	1	36	1	-1	1	90	300	1	42	53	1	0
2	0.6	0.1	0	15	15	0.7	4.3	0	1	82	19	17.6	0	1	33	1	0	1	90	300	-9	-9	-9	2	0
2	0.5	0.3	0	15	16	0.7	4.3	0	-1	82	18.9	17.4	0	1	34	1	0	1	90	300	-9	-9	-9	2	0
2	0.8	0.3	0	15	16	0.7	4.3	0	-1	82	18.9	17.4	0	1	35	1	0	1	90	300	-9	-9	-9	1	1
2	0.9	0.4	0	15	16	0.7	3.6	0	1	82	18.9	17.4	0	1	36	1	0	1	90	300	-9	-9	-9	2	0
2	1.8	0.4	0	15	16	0.7	3.6	0	-1	82	18.9	17.4	0	1	36	1	0	1	90	300	-9	-9	-9	1	1
2	1.7	0.4	0	15	16	0.7	3.6	0	1	82	18.9	17.4	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	0.6	0.4	0	15	16	0.7	3.6	0	-1	82	18.9	17.4	0	1	36	1	0	1	90	300	-9	-9	-9	1	0
2	1.7	0.4	0	15	16	0.7	3.6	0	-1	82	18.9	17.4	0	1	37	1	0	1	90	300	-9	-9	-9	1	0
2	0.3	0.5	0	15	16	0.7	3.6	0	-1	82	18.9	17.4	0	1	37	1	0	1	90	300	-9	-9	-9	2	0
2	0.4	0.6	0	15	16	0.7	3.6	0	-1	82	18.9	17.4	0	1	38	1	0	1	90	300	-9	-9	-9	1	0
2	1.6	0.6	0	15	16	0.7	3.6	0	-1	82	18.9	17.4	0	1	39	1	0	1	90	300	-9	-9	-9	1	0
1	0.3	0.9	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	42	1	0	1	90	300	3	55	1	2	0
1	0.6	0.9	0	15	15	0.6	3.6	0	1	80	19	17.3	0	1	42	1	0	1	90	300	4	51	18	1	1
1	0.2	1.1	0	15	15	0.6	3.6	0	1	80	19	17.3	0	1	45	1	0	1	90	300	4	51	18	1	0
1	0.5	1.2	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	45	1	-1	1	90	300	3	55	1	1	0
1	0	1.2	0	15	16	0.6	3.6	0	1	80	19.2	17.5	0	1	46	1	0	1	90	300	1	42	54	2	0
2	1.4	0.8	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	41	1	1	1	90	300	-9	-9	-9	1	1
2	0.9	0.8	0	15	15	0.6	3.6	0	0	80	19	17.3	-1	1	41	1	1	1	90	300	-9	-9	-9	2	0
2	0.3	0.9	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	42	1	1	1	90	300	-9	-9	-9	1	1
2	1.8	1	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	43	1	1	1	90	300	-9	-9	-9	1	0
2	0.8	1	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	43	1	1	1	90	300	-9	-9	-9	1	0
2	1.5	1	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	44	1	1	1	90	300	-9	-9	-9	1	0
2	1.5	1	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	44	1	-1	1	90	300	-9	-9	-9	1	1
2	0.6	1.1	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	44	1	1	1	90	300	-9	-9	-9	1	0
2	1.1	1.2	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	44	1	-1	1	90	300	-9	-9	-9	1	0
2	0.9	1.2	0	15	15	0.6	3.6	0	0	80	19	17.3	0	1	45	1	1	1	90	300	-9	-9	-9	2	0
2	1.2	1.3	0	15	16	0.6	3.6	0	0	80	19.2	17.5	0	1	46	1	-1	1	90	300	-9	-9	-9	1	0
2	2.1	1.3	0	15	16	0.6	4.3	0	0	80	19.2	17.5	0	1	46	1	-1	1	90	300	-9	-9	-9	1	0
1	1.4	1.6	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	55	1	0	1	90	300	1	42	54	1	0
1	0.9	1.6	0	15	14	0.2	4.3	0	-1	78	19.1	17.5	0	1	56	1	0	1	90	300	4	51	18	1	1
2	2.1	1.4	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	53	1	0	1	90	300	-9	-9	-9	1	1
2	0.8	1.4	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	53	1	0	1	90	300	-9	-9	-9	2	0
2	0.9	1.5	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	54	1	0	1	90	300	-9	-9	-9	1	1
2	0	1.5	0	15	14	0.2	4.3	0	0	78	19.1	17.5	0	1	55	1	1	1	90	300	-9	-9	-9	1	1
2	1.4	1.6	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	55	1	0	1	90	300	-9	-9	-9	1	0
2	0.3	1.6	0	15	14	0.2	4.3	0	-1	78	19.1	17.5	0	1	55	1	0	1	90	300	-9	-9	-9	2	0
2	0.8	1.6	0	15	14	0.2	4.3	0	-1	78	19.1	17.5	0	1	55	1	0	1	90	300	-9	-9	-9	2	0
2	1.6	1.7	0	15	14	0.2	4.3	0	-1	78	19.1	17.5	0	1	56	1	0	1	90	300	-9	-9	-9	1	1
2	1.7	1.7	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	56	1	0	1	90	300	-9	-9	-9	1	0
2	0.5	1.7	0	15	14	0.2	4.3	0	-1	78	19.1	17.5	0	1	57	1	0	1	90	300	-9	-9	-9	1	0
2	1.3	1.7	0	15	14	0.2	4.3	0	-1	78	19.1	17.5	0	1	57	1	0	1	90	300	-9	-9	-9	1	0
2	0.8	1.8	0	15	14	0.2	4.3	0	1	78	19.1	17.5	0	1	57	1	0	1	90	300	-9	-9	-9	1	0
2	0.3	1.8	0	15	14	0.2	3.6	0	-1	78	19.1	17.5	1	1	57	1	0	1	90	300	-9	-9	-9	2	0
2	0.6	1.8	0	15	14	0.2	3.6	0	-1	78	19.1	17.5	0	1	58	1	0	1	90	300	-9	-9	-9	1	0
2	1.4	1.9	0	15	14	0.2	3.6	0	-1	78	19.1	17.5	0	1	58	1	0	1	90	300	-9	-9	-9	1	0
1	0.4	2.3	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	61	1	-1	1	90	300	4	51	18	1	1
2	1.4	2.1	0	15	14	0.2	3.6	0	0	78	19.1	17.5	0	1	59	1	1	1	90	300	-9	-9	-9	1	1
2	0.7	2.1	0	15	14	0.2	3.6	0	0	78	19.1	17.5	0	1	60	1	1	1	90	300	-9	-9	-9	2	0
2	0.3	2.1	0	15	14	0.2	3.6	0	0	78	19.1	17.5	0	1	60	1	-1	1	90	300	-9	-9	-9	2	0
2	0.3	2.2	0	15	14	0.2	3.6	0	0	78	19.1	17.5	0	1	60	1	1	1	90	300	-9	-9	-9	1	1
2	1.7	2.3	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	61	1	1	1	90	300	-9	-9	-9	1	0
2	0.5	2.3	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	61	1	1	1	90	300	-9	-9	-9	1	0
2	1	2.3	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	61	1	1	1	90	300	-9	-9	-9	1	0

CG-1471 OCTOBER 05 1990 (Continued)

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	SS	WHCAPS	SWDIR	RELHUM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.1	2.4	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	62	1	1	1	90	300	-9	-9	-9	2	0
2	1.2	2.4	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	62	1	-1	1	90	300	-9	-9	-9	1	0
2	2	2.4	0	15	12	0.2	3.6	0	0	78	19	17.4	0	1	62	1	-1	1	90	300	-9	-9	-9	1	0

EOF

CG-41337 OCTOBER 10 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	SS	WHCAPS	SWDIR	RELHUM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1	0.3	0	10	18	1	3.6	1	0	89	15.2	17.5	-1	1	-19	0	0	0.5	10	1	-9	-9	-9	2	-1

EOF

CG-41441 OCTOBER 10 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	SS	WHCAPS	SWDIR	RELHUM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.4	0.3	0	10	17	1	3.6	1	0	89	15.4	17.6	0	1	-21	0	0	0.5	10	1	-9	-9	-9	2	-1

EOF

CG-41342 OCTOBER 10 1990

DET	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	SS	WHCAPS	SWDIR	RELHUM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	FHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	1	0.1	0	10	17	1	3.3	1	1	89	15.9	17.6	0	0	-22	0	1	0.5	12	0	-9	-9	-9	2	-1
2	0.1	0.2	0	10	17	1	3.6	1	1	89	15.4	17.6	1	1	-22	0	1	0.5	12	0	-9	-9	-9	2	-1

EOF

CG-41337 OCTOBER 12 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHUM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.1	0.6	0	5	10	0	2.5	0	0	95	21	19	0	1	-26	0	-1	0.2	15	1	-9	-9	-9	1	0
2	0.6	1.4	0	5	10	0	2.5	0	0	95	21	19	0	1	-22	0	-1	0.2	15	1	-9	-9	-9	2	-1
2	0.2	1.6	0	5	10	0	2.5	0	0	95	21	19	0	1	-18	0	1	0.2	15	1	-9	-9	-9	2	-1
2	0.7	2	0	5	10	0	2.5	0	0	95	21	19	0	1	-16	0	-1	0.2	15	1	-9	-9	-9	2	-1
2	0.6	0.3	0	5	10	0	2.5	0	0	95	21	19	0	1	-28	0	-1	0.2	15	1	-9	-9	-9	1	0

EOF

CG-41342 OCTOBER 12 1990

DIST	LATRNG	TOT	PRECIP	VIS	WDSP	CLDC	HS	WHCAPS	SWDIR	RELHUM	AIRTP	WTTP	RELAZ	LEV	ELEV	MOONVIS	MOONRA	PHS	SPD	ALTTYPE	POS	LO	EXP	TYNO	SUBTY
2	0.2	0.9	0	2.5	9	0.1	2.5	0	0	93	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	2	-1
2	0.4	0.2	0	2.5	9	0.1	2.5	0	0	93	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	1	0
2	0.5	0.3	0	2.5	9	0.1	2.5	0	0	93	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	2	-1
2	1	0.4	0	2.5	9	0.1	2.5	0	0	93	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	1	0
2	0.2	0.5	0	2.5	9	0.1	2.5	0	0	93	21	19	0	0	-32	0	0	0.2	23	0	-9	-9	-9	2	-1
2	0.3	0.8	0	2.5	9	0.1	2.5	0	0	93	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	2	-1
2	0.2	1	0	2.5	11	0.1	2.5	0	0	95	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	2	-1
2	0.6	1.2	0	2.5	11	0.1	2.5	0	0	95	21	19	0	1	-32	0	0	0.2	23	0	-9	-9	-9	1	0
2	0.6	1.5	0	2.5	11	0.1	2.5	0	0	95	21	19	0	1	-32	0	1	0.2	23	0	-9	-9	-9	1	0
2	0.6	1.7	0	2.5	11	0.1	2.5	0	0	95	21	19	0	1	-31	0	-1	0.2	23	0	-9	-9	-9	2	-1
2	0.7	1.8	0	2.5	11	0.1	2.5	0	0	95	21	19	0	1	-31	0	0	0.2	23	0	-9	-9	-9	2	-1
2	0.7	1.8	0	2.5	11	0.1	2.5	0	0	95	21	19	0	1	-30	0	-1	0.2	23	0	-9	-9	-9	2	-1
2	0.6	2.5	0	6	10	0	2.5	0	0	95	21	19	0	1	-28	0	-1	0.2	23	0	-9	-9	-9	2	-1
2	0.1	2.6	0	6	10	0	2.5	0	0	95	21	19	0	1	-27	0	0	0.2	23	0	-9	-9	-9	2	-1
2	0.5	2.9	0	6	10	0	2.5	0	0	95	21	19	0	1	-26	0	1	0.2	23	0	-9	-9	-9	2	-1
2	1	2.9	0	6	10	0	2.5	0	0	95	21	19	0	1	-26	0	-1	0.2	23	0	-9	-9	-9	1	0
2	0.2	3	0	6	10	0	2.5	0	0	95	21	19	0	0	-25	0	-1	0.2	23	0	-9	-9	-9	2	-1
2	0.9	3.2	0	6	10	0	2.5	0	0	95	21	19	0	0	-24	0	1	0.2	23	0	-9	-9	-9	2	-1
2	0.1	3.2	0	6	10	0	2.5	0	0	95	21	19	0	1	-23	0	1	0.2	23	0	-9	-9	-9	1	0
2	0.5	3.6	0	4	10	0	2.5	0	0	95	21	19	0	1	-20	0	1	0.2	23	0	-9	-9	-9	2	-1
2	1	3.8	0	4	10	0	2.5	0	0	95	21	19	0	1	-20	0	-1	0.2	23	0	-9	-9	-9	1	0
2	0.3	3.7	0	4	10	0	2.5	0	0	95	21	19	0	0	-20	0	-1	0.2	23	0	-9	-9	-9	2	-1

EOF